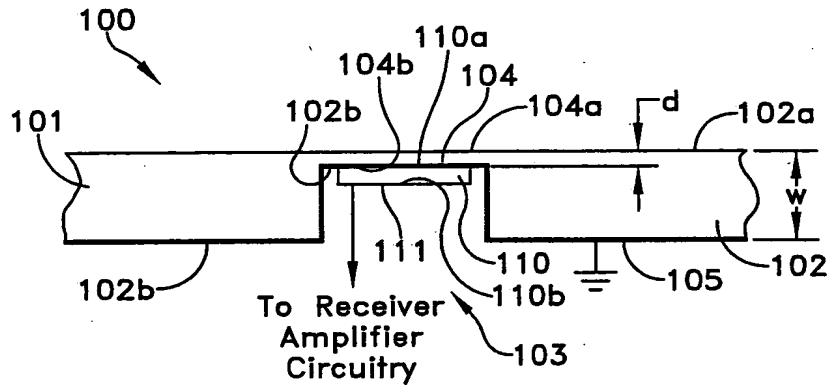


FIG. 1

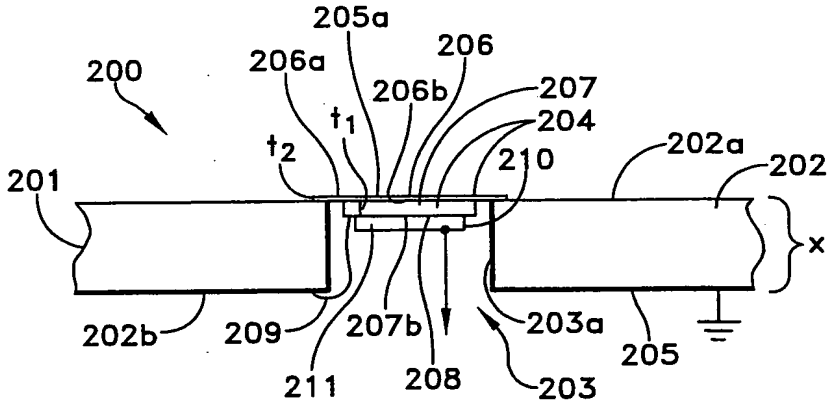

205a
206a
206
200
206b
207
204
t_1
t_2
210
202a
202
201
x
202b
209
207b
203a
205
211
208
203

FIG. 2

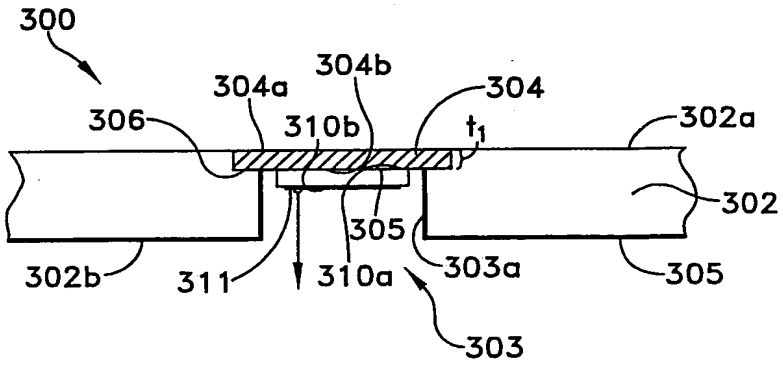

300
304b
304a
304
306
310b
t_1
302a
302
305
303a
302b
311
310a
305
303

FIG. 3

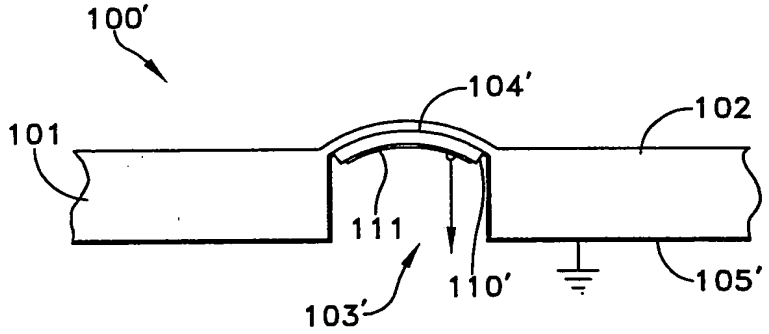

100'
104'
102
101
111
110'
105'
103'

FIG. 4

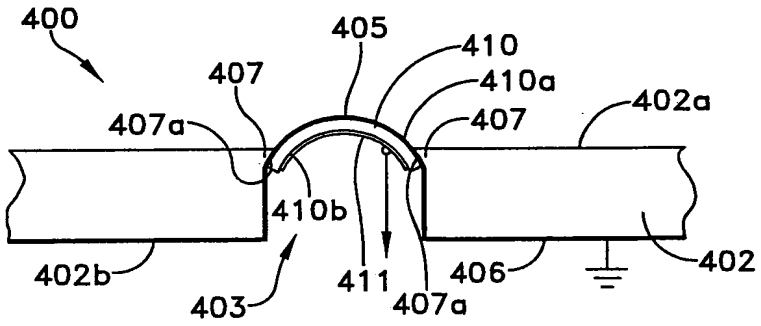

400
405
410
410a
407
407a
407
402a
410b
402b
403
411
406
407a
402

FIG. 5

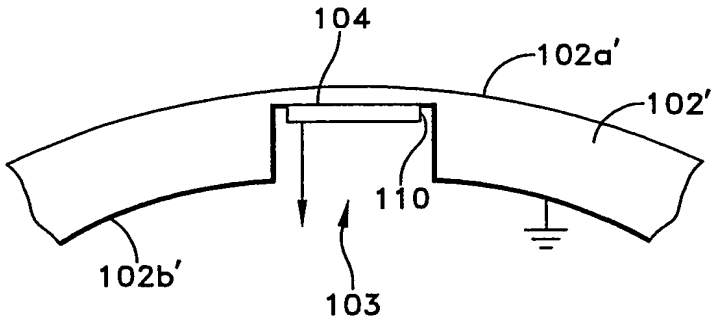


FIG. 6A

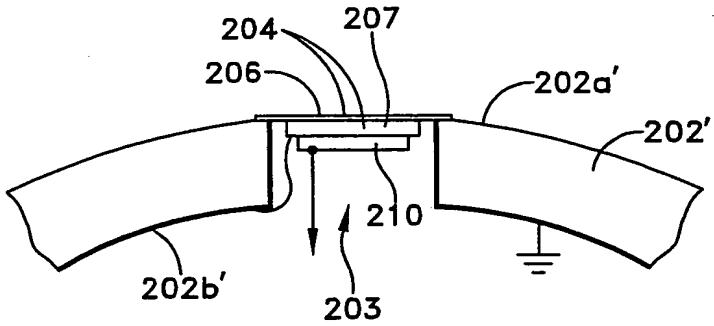


FIG. 6B

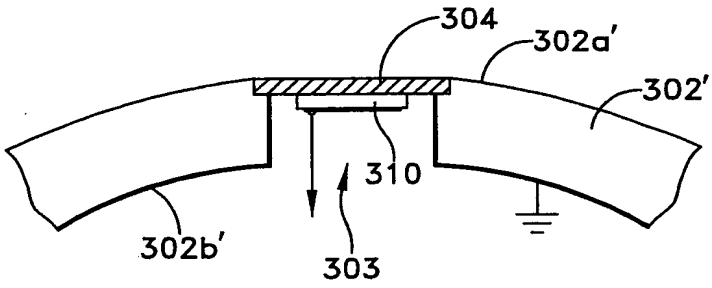


FIG. 6C

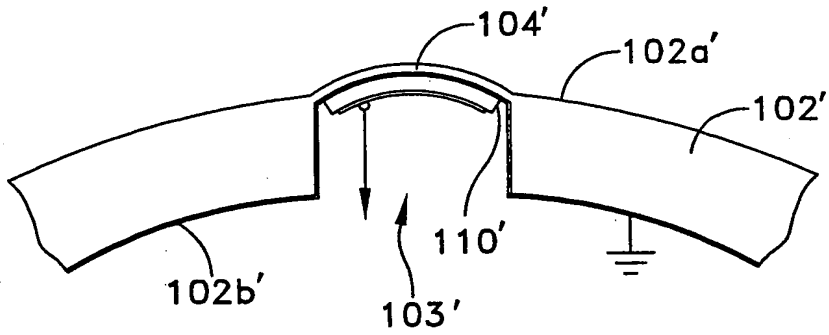


FIG. 6E

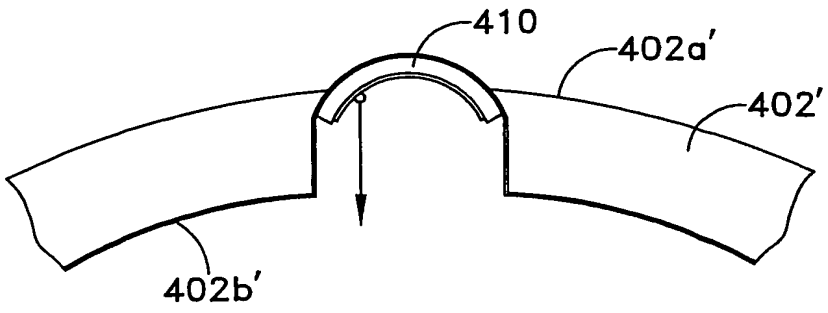


FIG. 6D

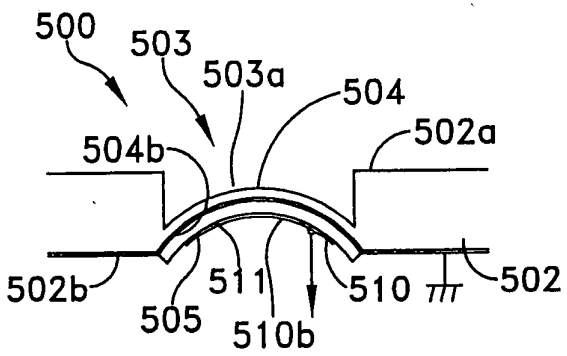


FIG. 7A

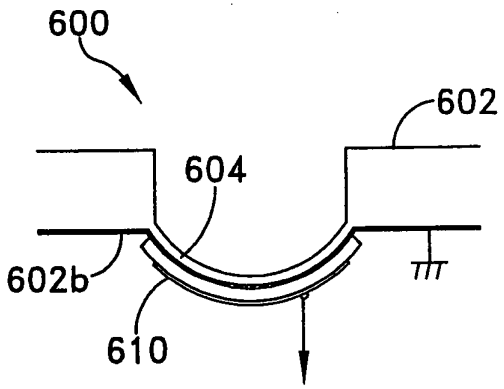


FIG. 8A

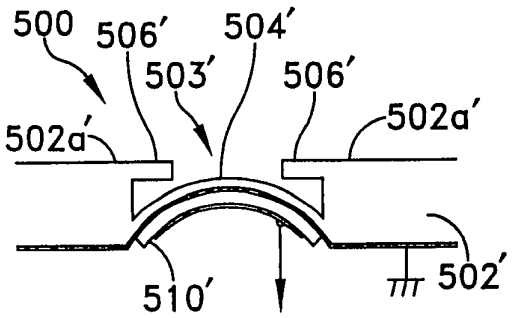


FIG. 7B

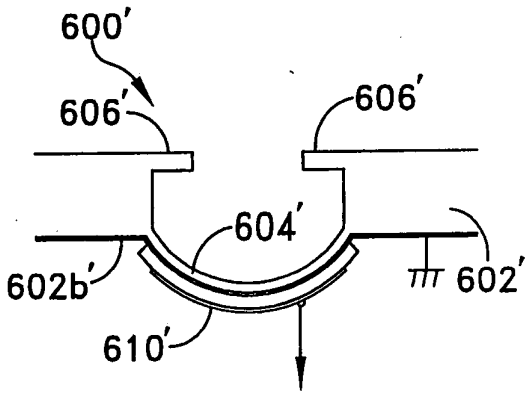


FIG. 8B

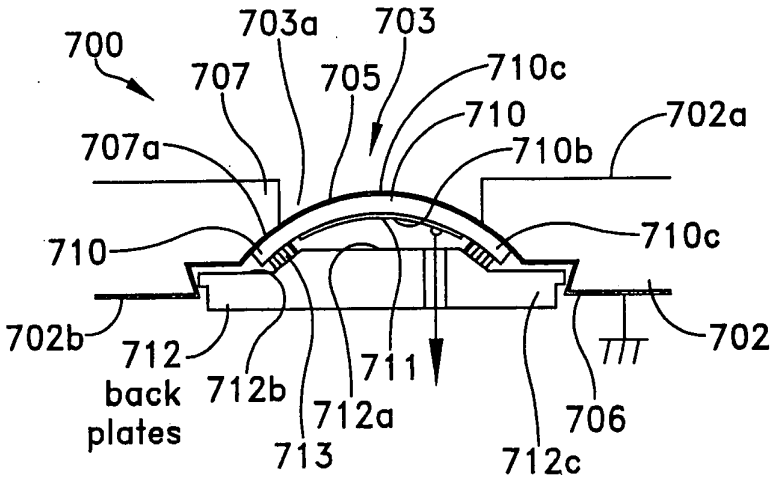


FIG. 9A

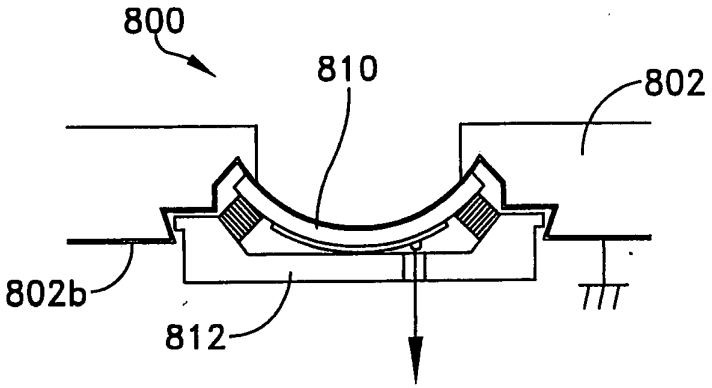


FIG. 10A

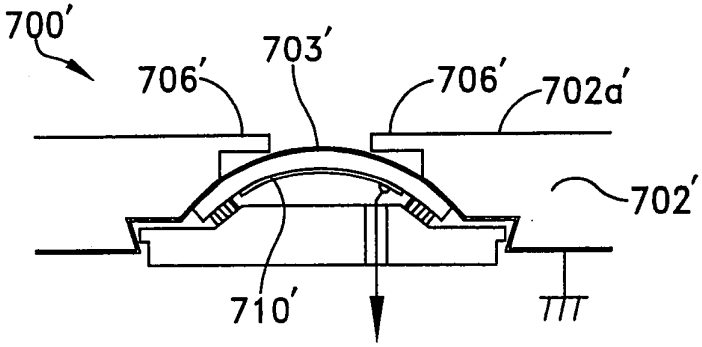


FIG. 9B

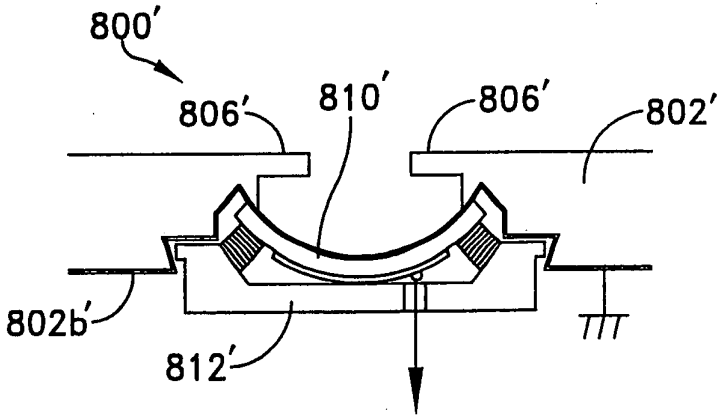


FIG. 10B

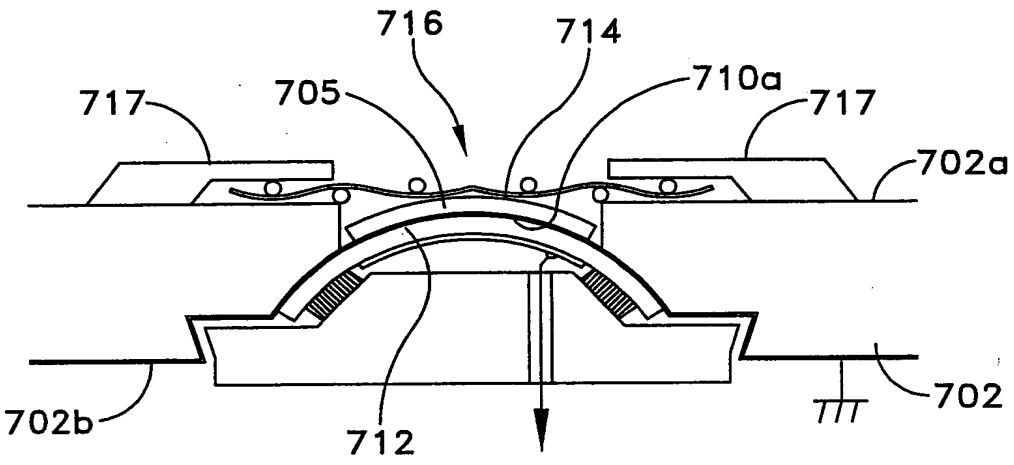


FIG. 11

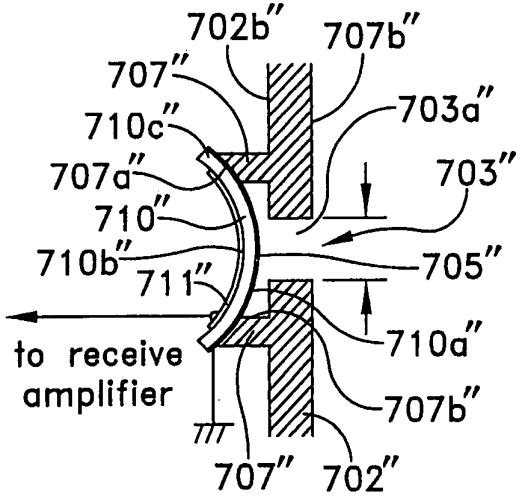


FIG. 12

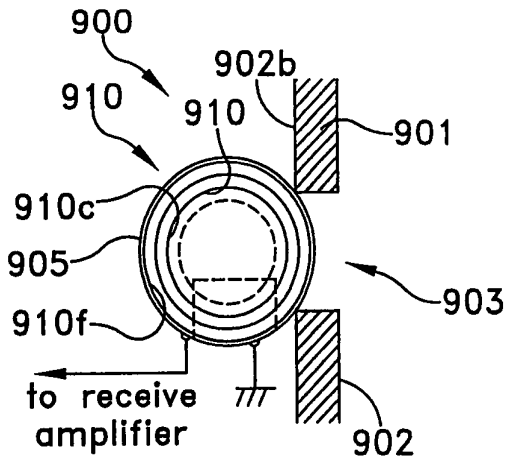


FIG. 13

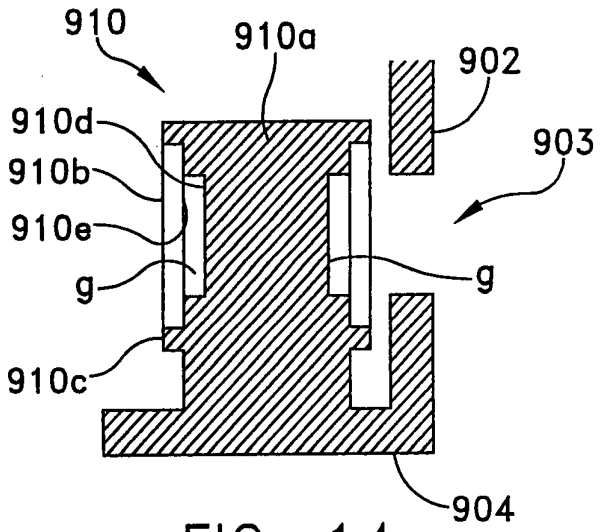


FIG. 14

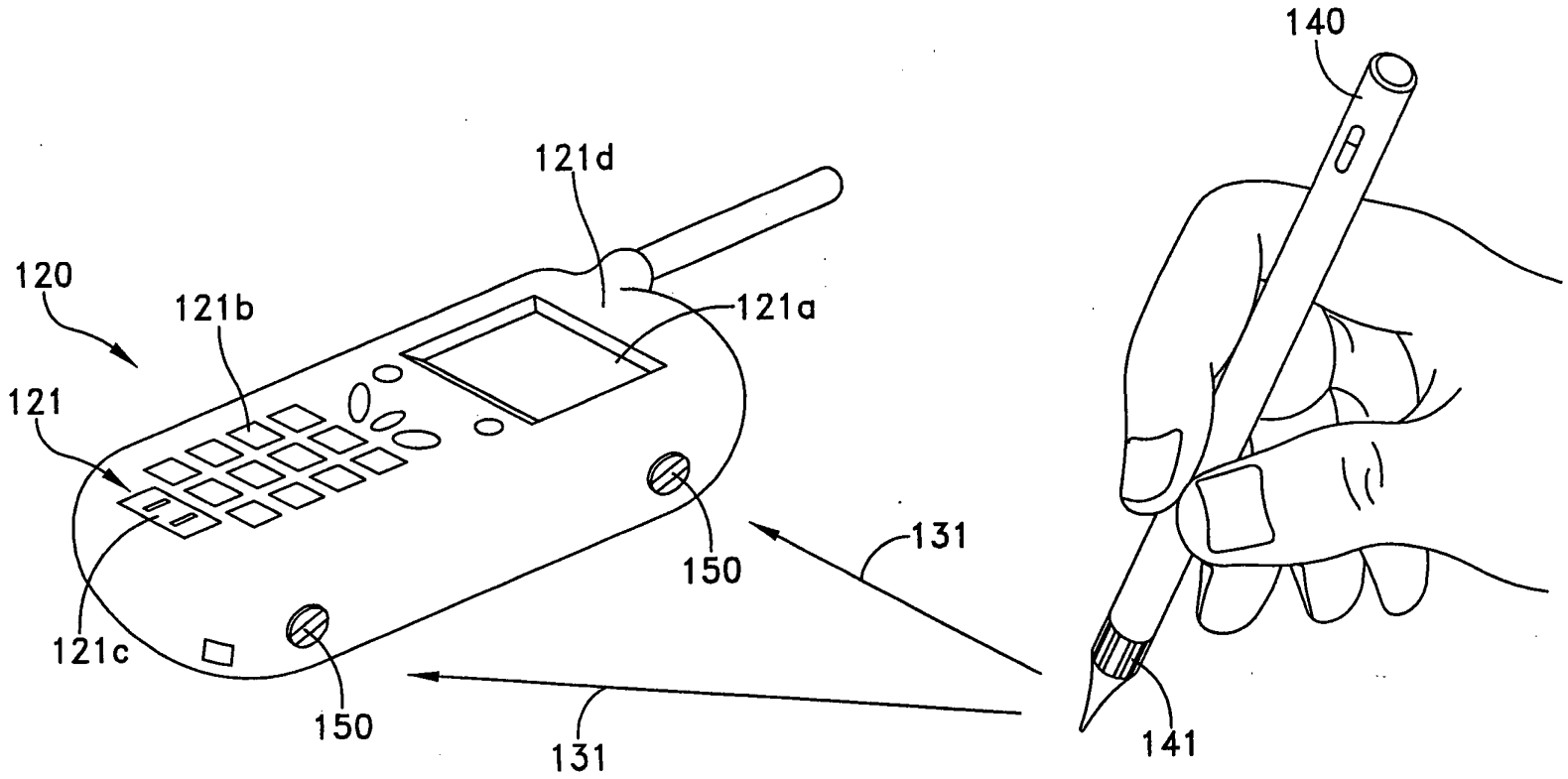


FIG. 15

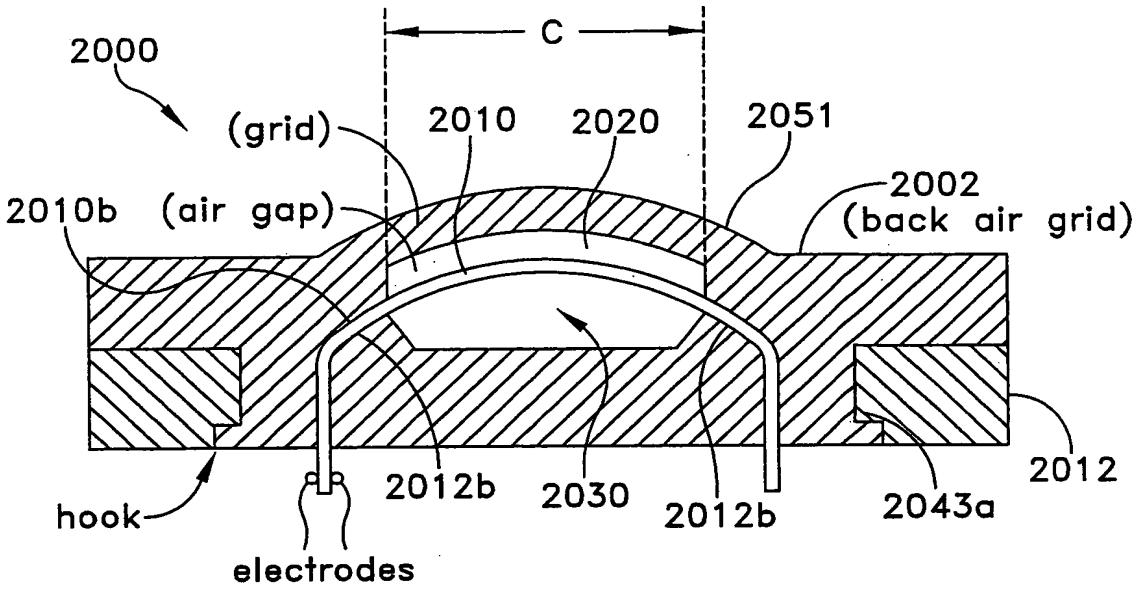

C
2000
(grid)
2010
2020
2051
2002
(back air grid)
2010b
(air gap)
2012
hook
2012b
2030
2012b
2043a
electrodes

FIG. 16

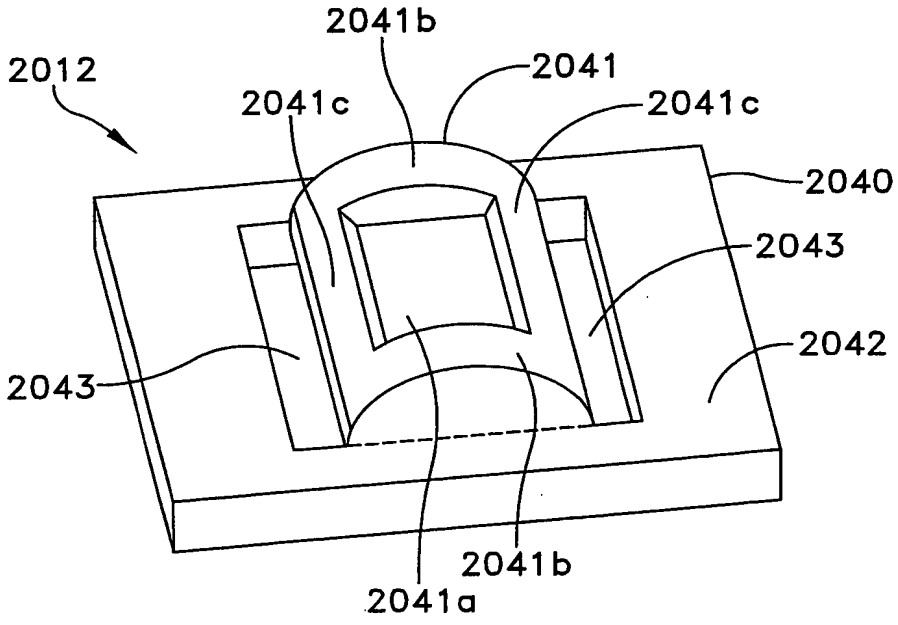

2041b
2012
2041
2041c
2041c
2040
2043
2042
2043
2041b
2041a

FIG. 17

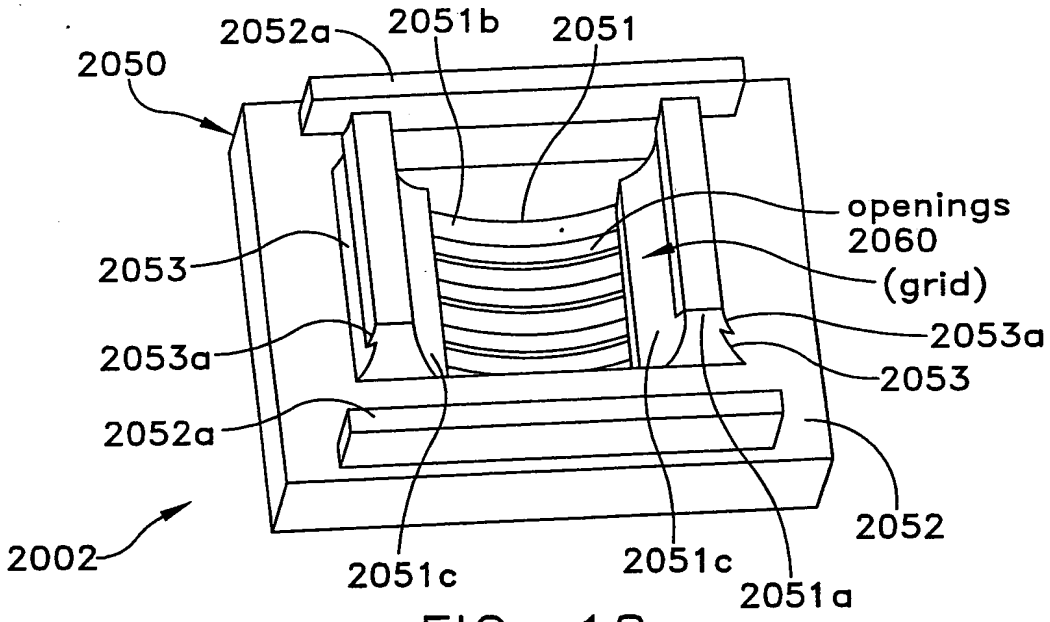


FIG. 18

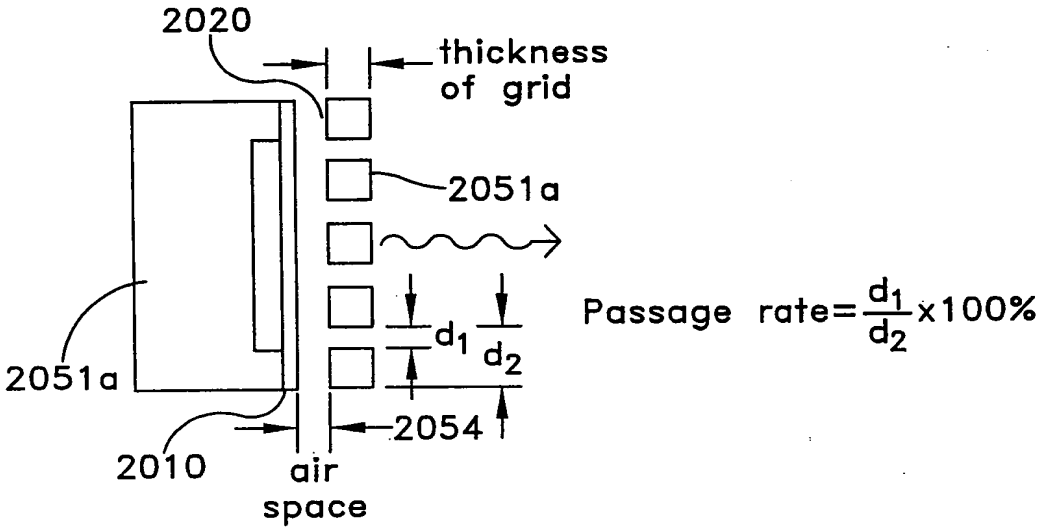


FIG. 19

30% Passage			40% Passage			60% Passage		
Air space	Wall Thick	Improve-ment	Air space	Wall Thick	Improve-ment	Air space	Wall Thick	Improve-ment
0.08mm	0.5mm	82%	0.08mm	0.5mm	50%	0.1mm	0.5mm	38%
0.05	1.0	55	0.08	1.0	35	0.1	1.0	22
0.08	1.5	32	0.1	1.5	19	0.1	1.5	8

FIG. 23

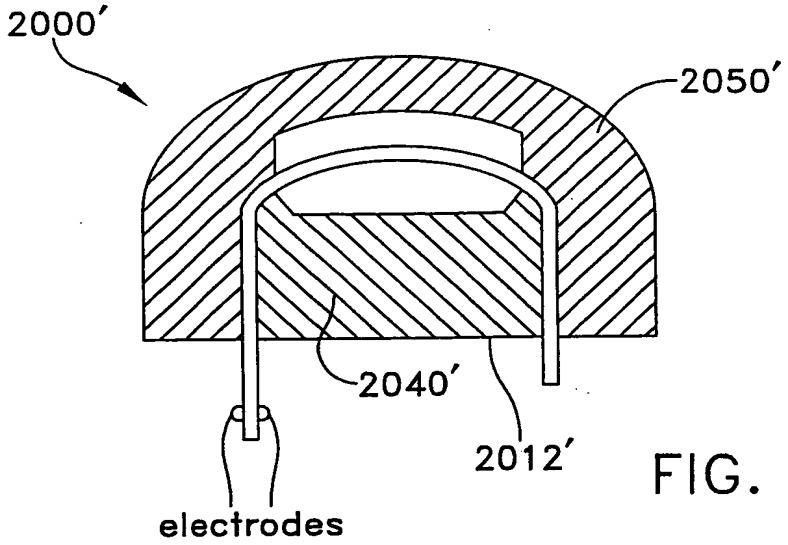


FIG. 20

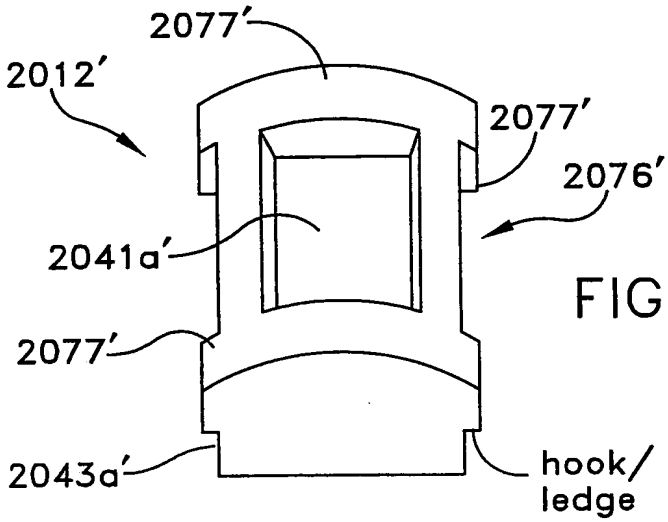


FIG. 21

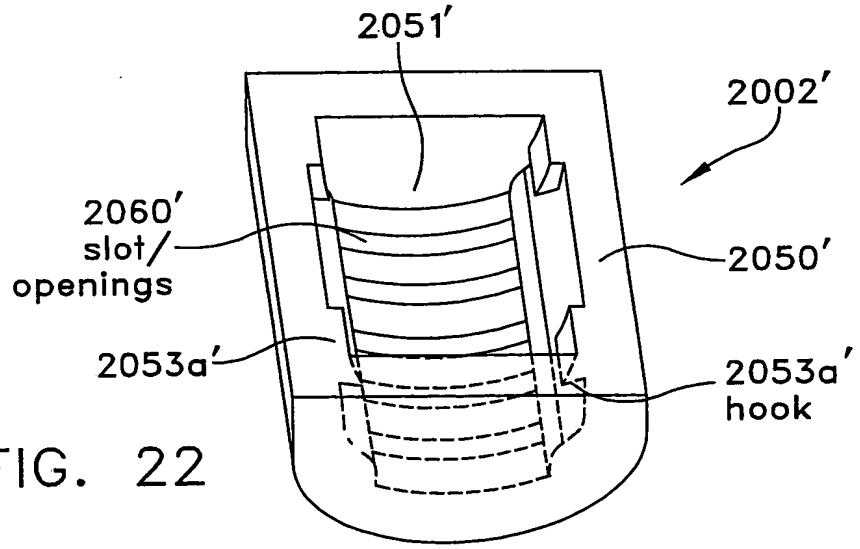


FIG. 22

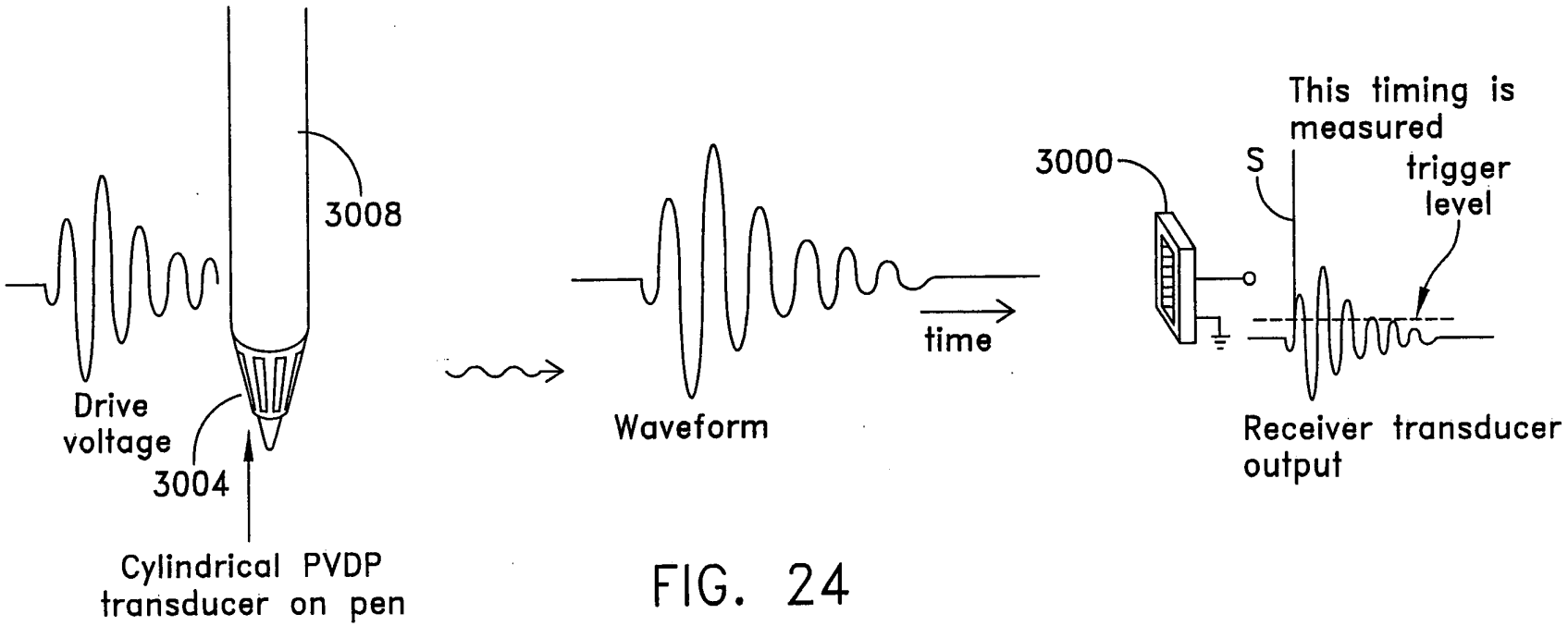

3008
Drive voltage
3004
Cylindrical PVDP transducer on pen
Waveform
time
This timing is measured
3000
S
trigger level
Receiver transducer output

FIG. 24

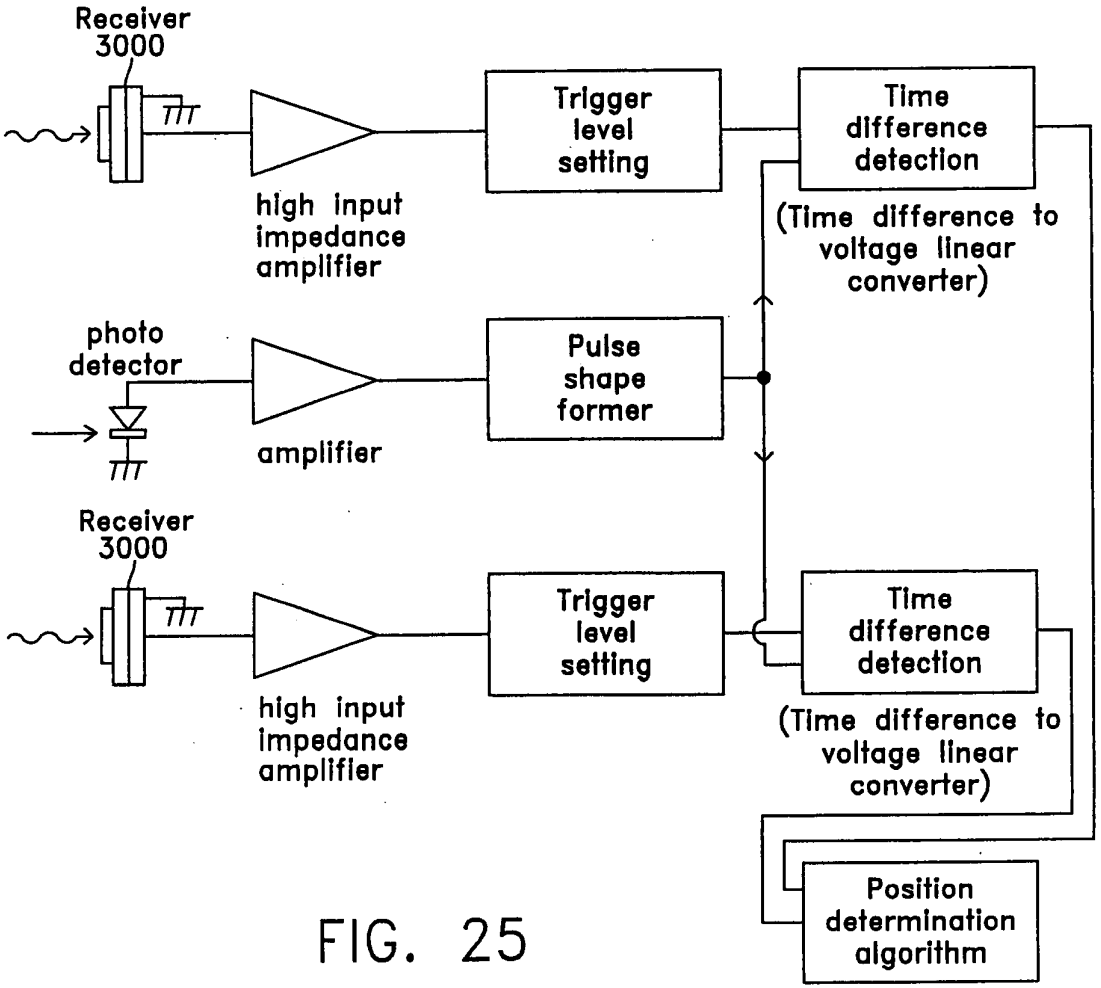

Receiver
3000
high input
impedance
amplifier
Trigger
level
setting
Time
difference
detection
(Time difference to
voltage linear
converter)
photo
detector
amplifier
Pulse
shape
former
Receiver
3000
high input
impedance
amplifier
Trigger
level
setting
Time
difference
detection
(Time difference to
voltage linear
converter)
Position
determination
algorithm

FIG. 25

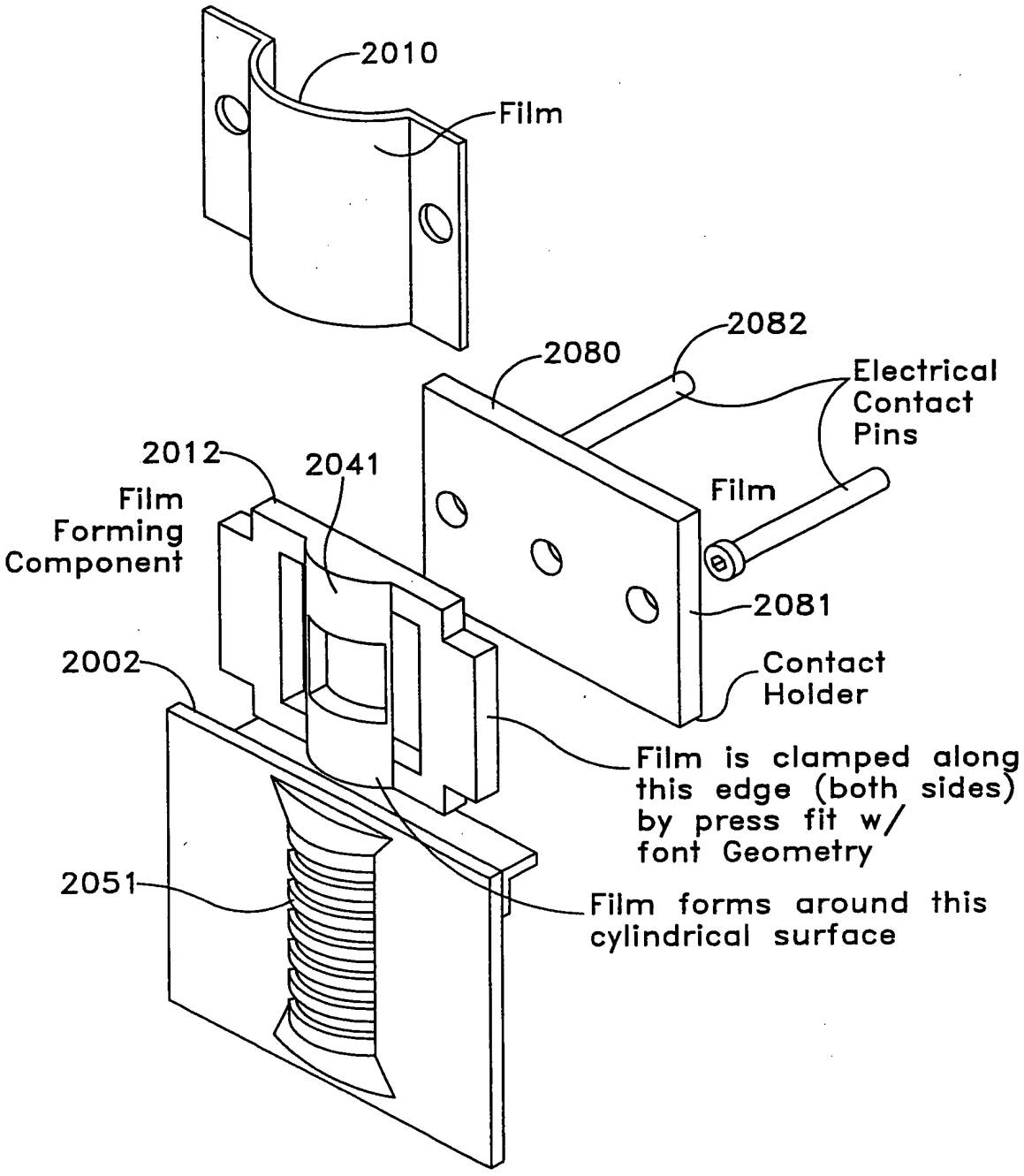

2010
Film
2082
2080
Electrical
Contact
Pins
2012
2041
Film
Forming
Component
Film
2081
2002
Contact
Holder
Film is clamped along
this edge (both sides)
by press fit w/
font Geometry
2051
Film forms around this
cylindrical surface

FIG. 26

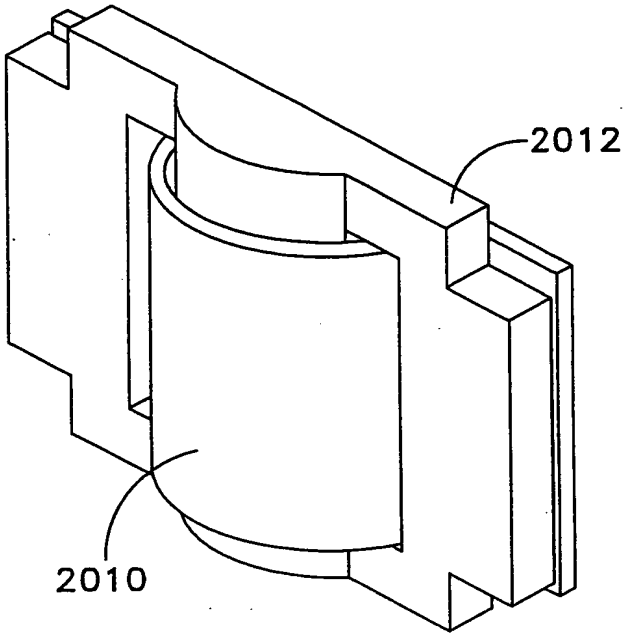


FIG. 27

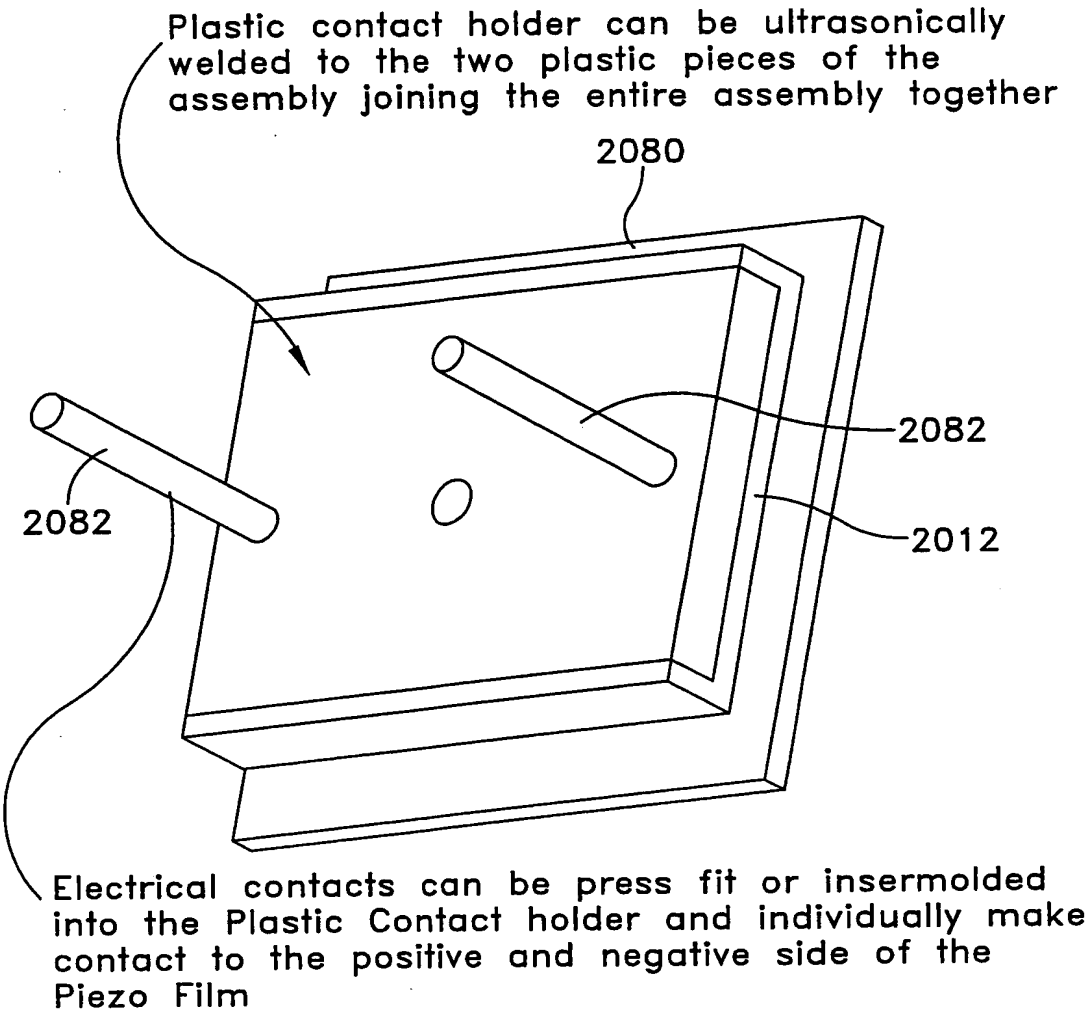

Plastic contact holder can be ultrasonically welded to the two plastic pieces of the assembly joining the entire assembly together
2080
2082
2082
2012
Electrical contacts can be press fit or insermolded into the Plastic Contact holder and individually make contact to the positive and negative side of the Piezo Film

FIG. 28

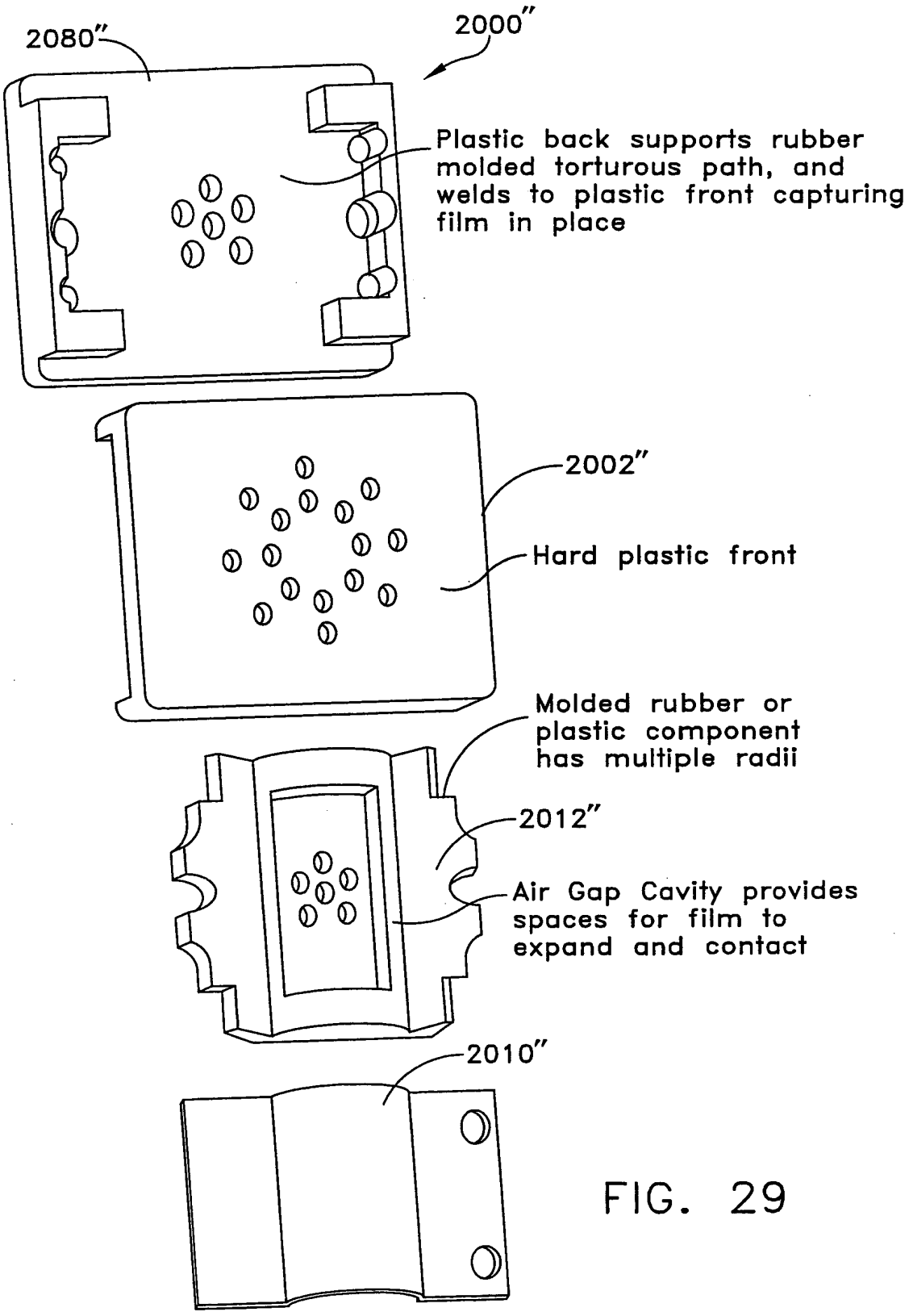

2080"
2000"
Plastic back supports rubber molded torturous path, and welds to plastic front capturing film in place
2002"
Hard plastic front
Molded rubber or plastic component has multiple radii
2012"
Air Gap Cavity provides spaces for film to expand and contact
2010"

FIG. 29

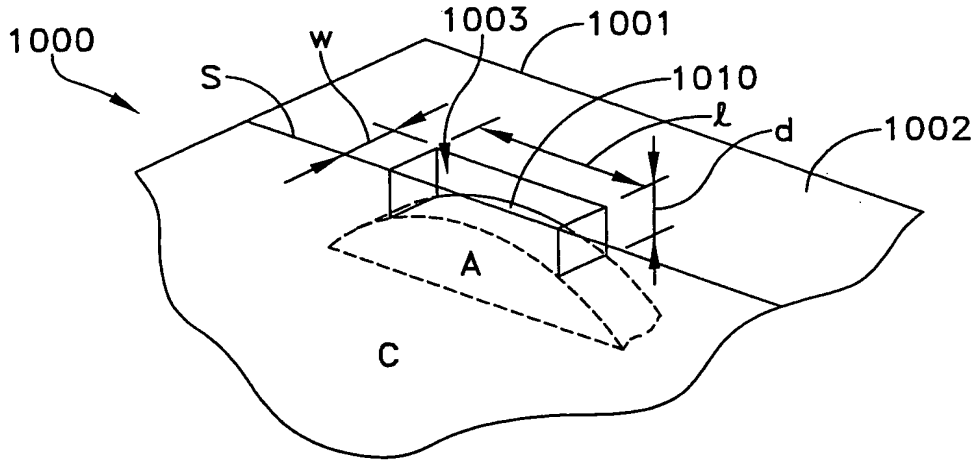


FIG. 30A

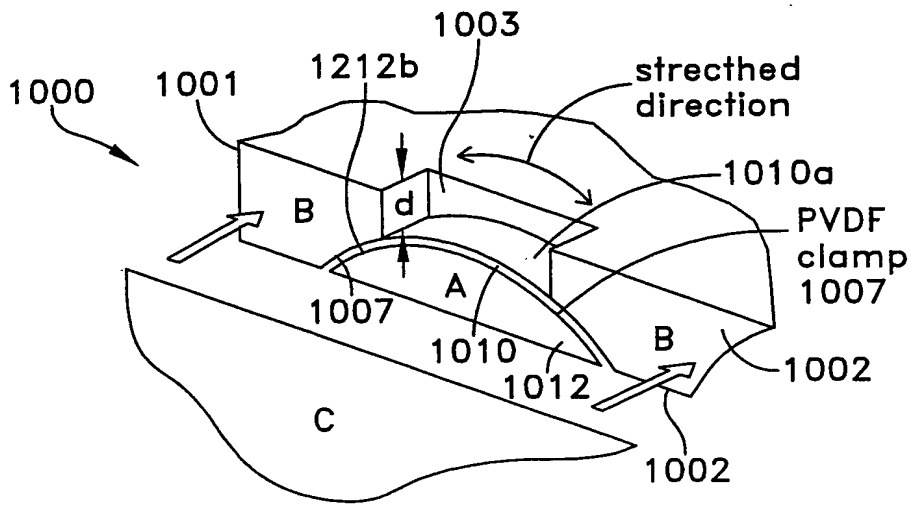


FIG. 31

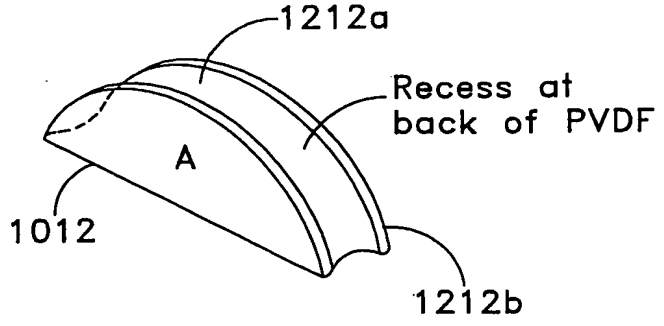


FIG. 32

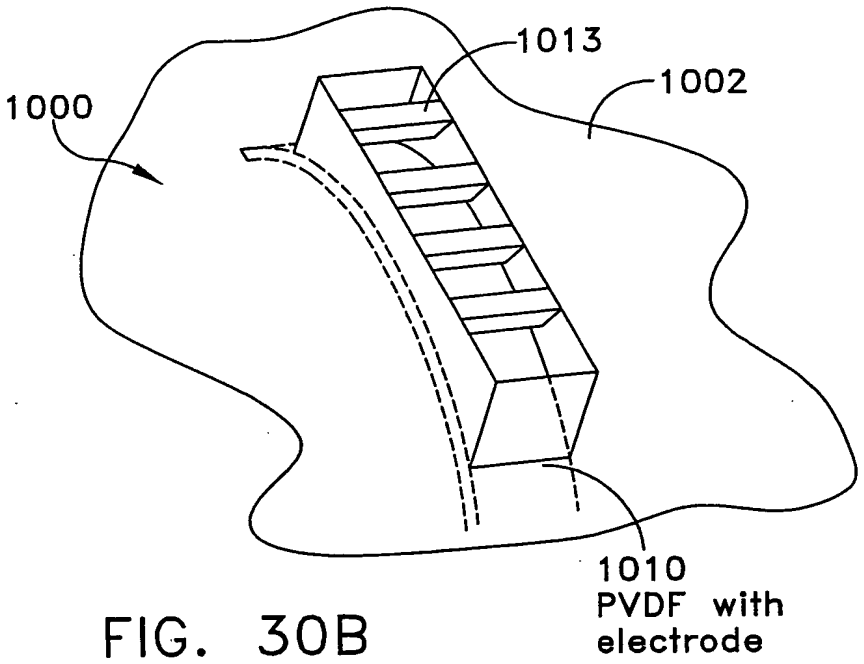


FIG. 30B

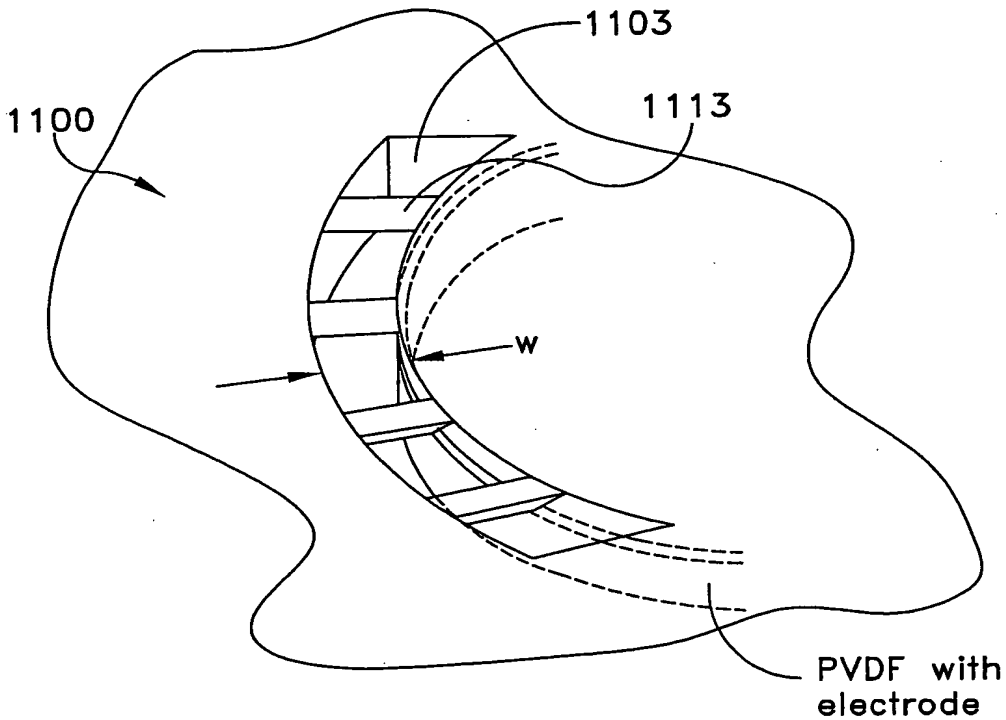


FIG. 33B

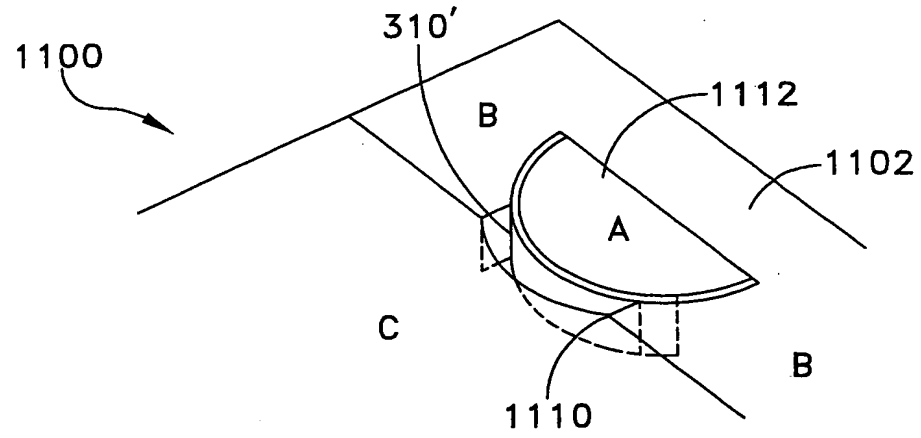


FIG. 33A

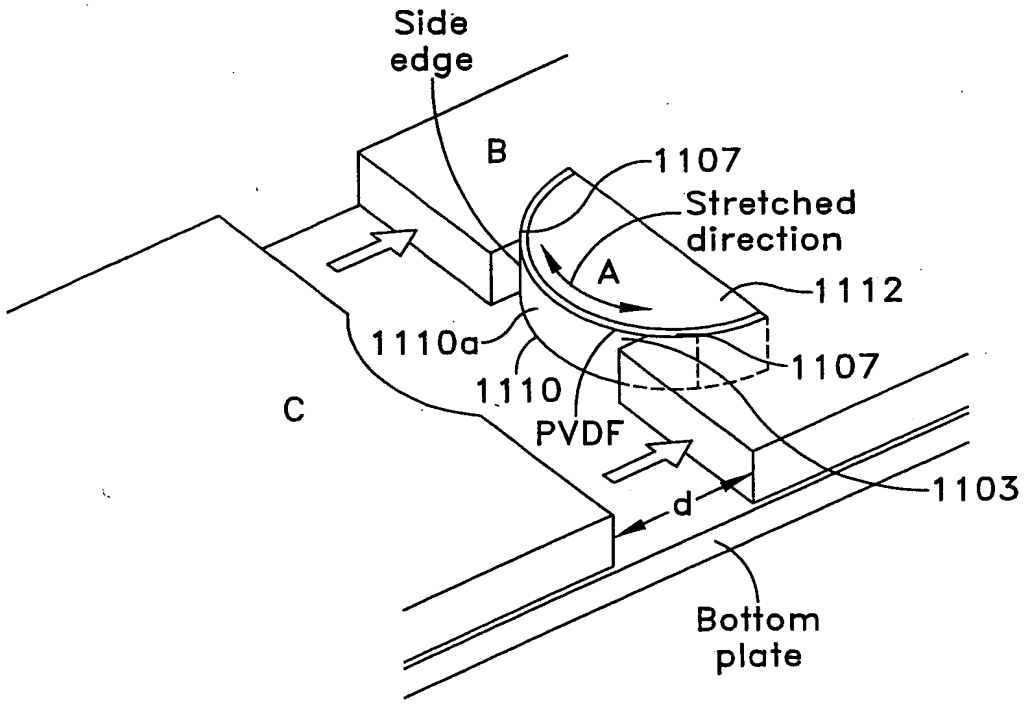


FIG. 34

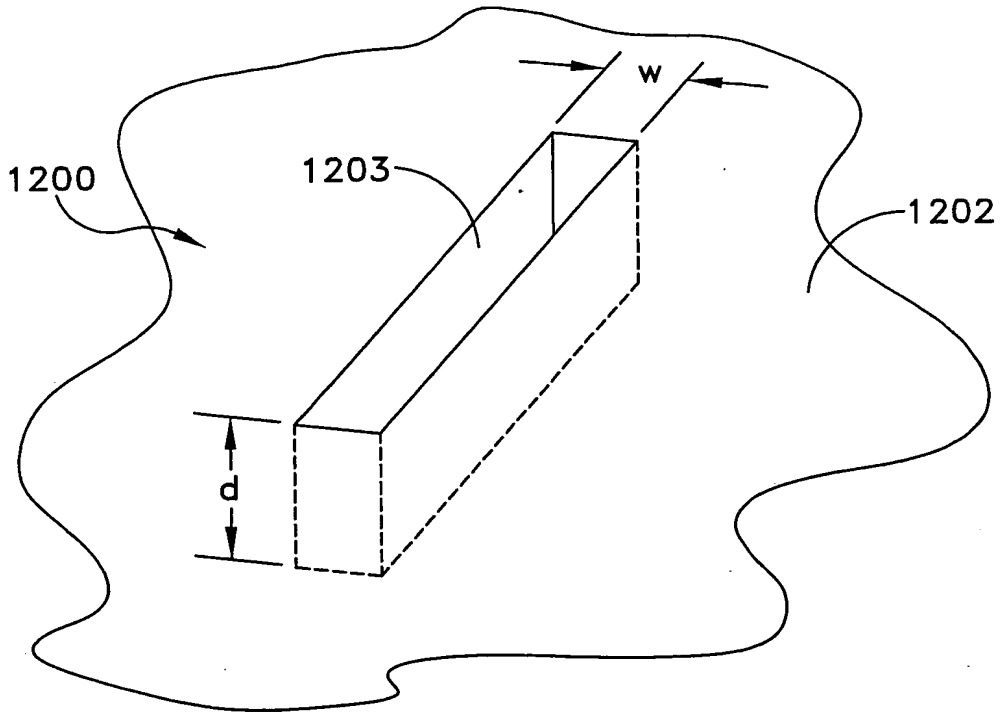


FIG. 35A

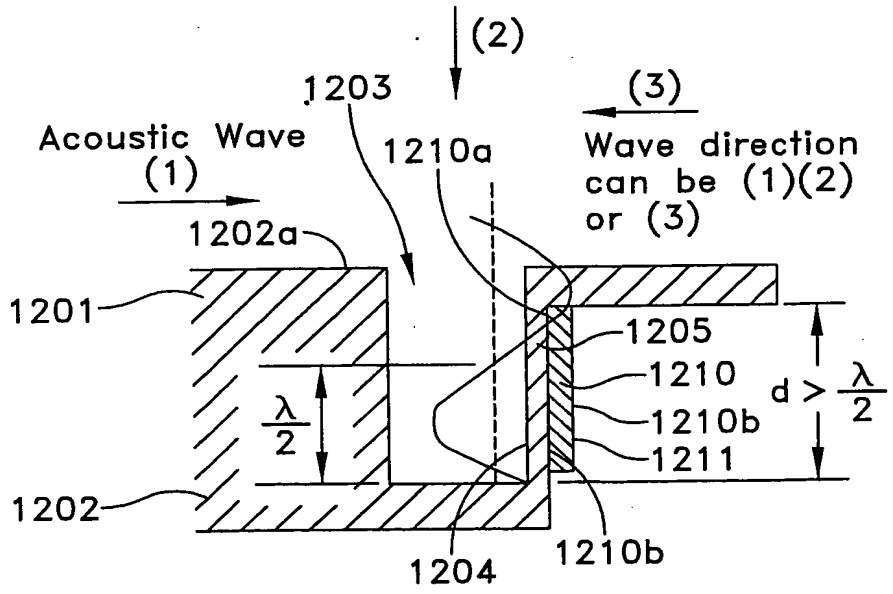


FIG. 35B

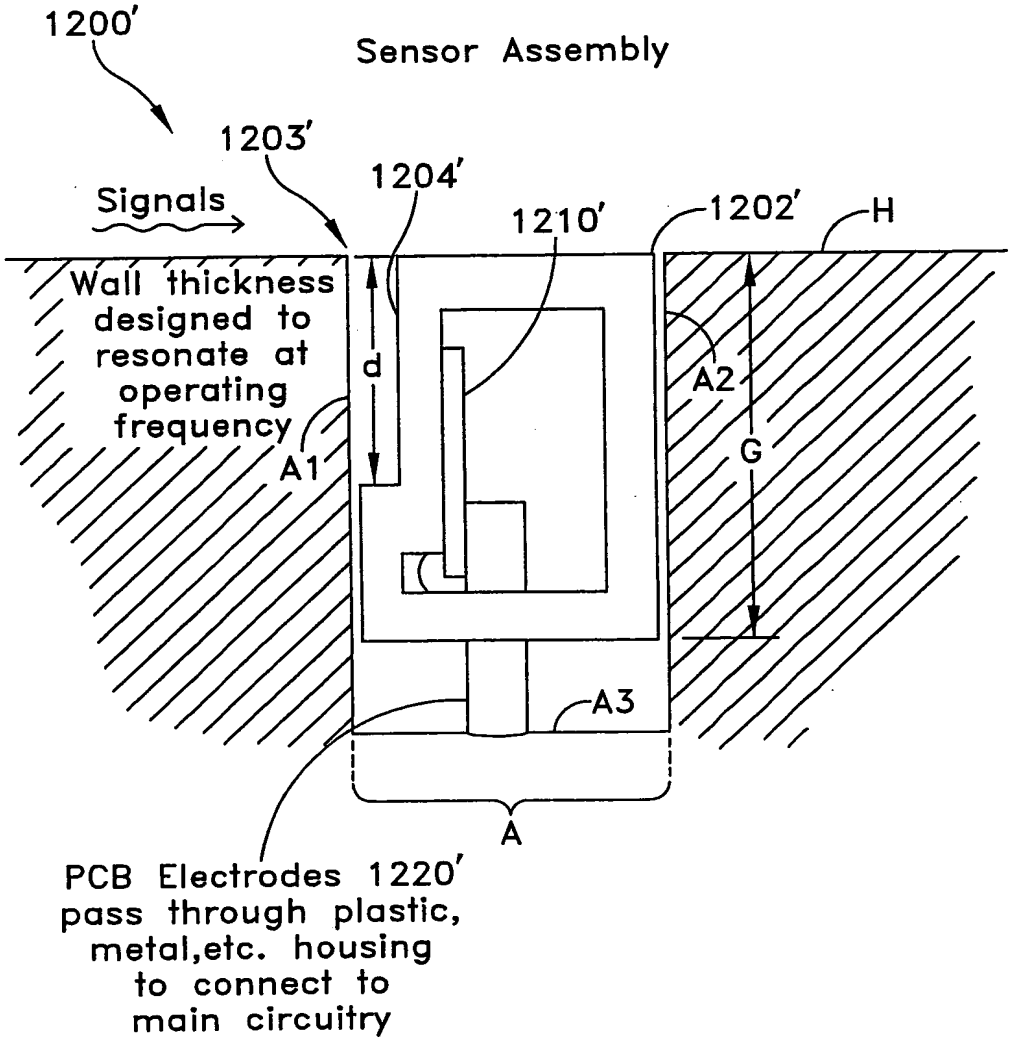

1200'
Sensor Assembly
1203'
1204'
Signals
1210'
1202'
H
Wall thickness designed to resonate at operating frequency
d
A1
A2
G
A3
A
PCB Electrodes 1220' pass through plastic, metal,etc. housing to connect to main circuitry

FIG. 35C

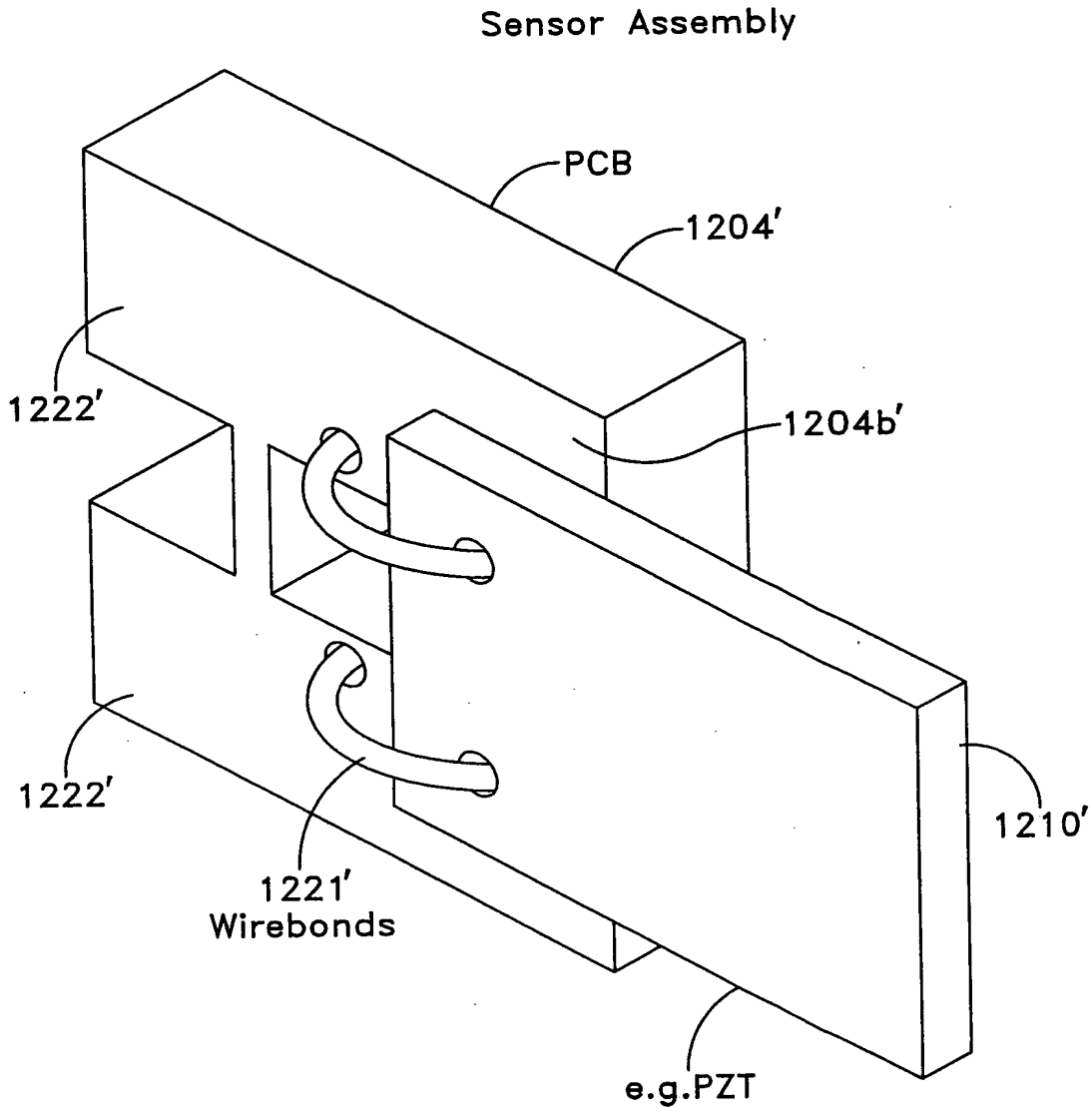
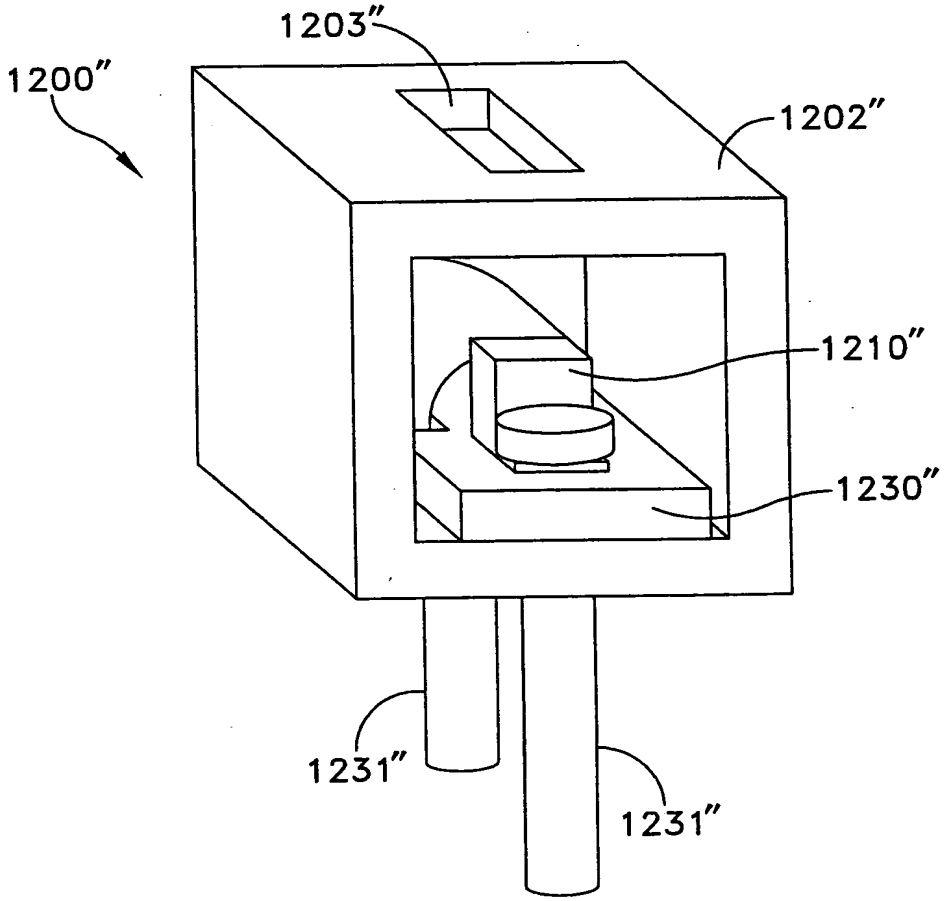

Sensor Assembly
PCB
1204'
1222'
1204b'
1222'
1221'
Wirebonds
1210'
e.g.PZT

FIG. 35D

Semi–Cylindrical Sensor

Plastic Housing w/Cutout for Accoustic Energy to pass



Electric Contacts pass through housing to connect to main circuit

FIG. 35E

Semi Cylindrical Sensor

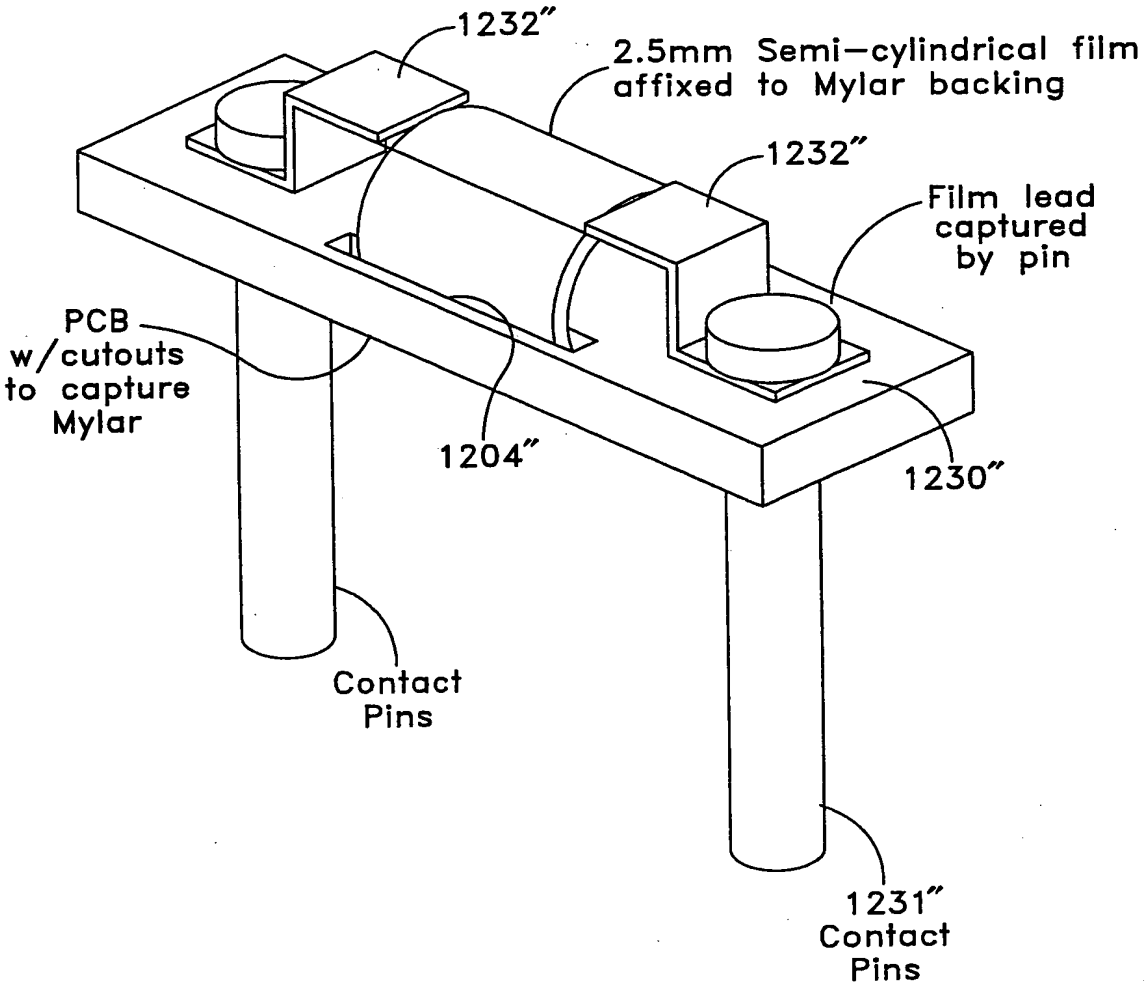


FIG. 35F

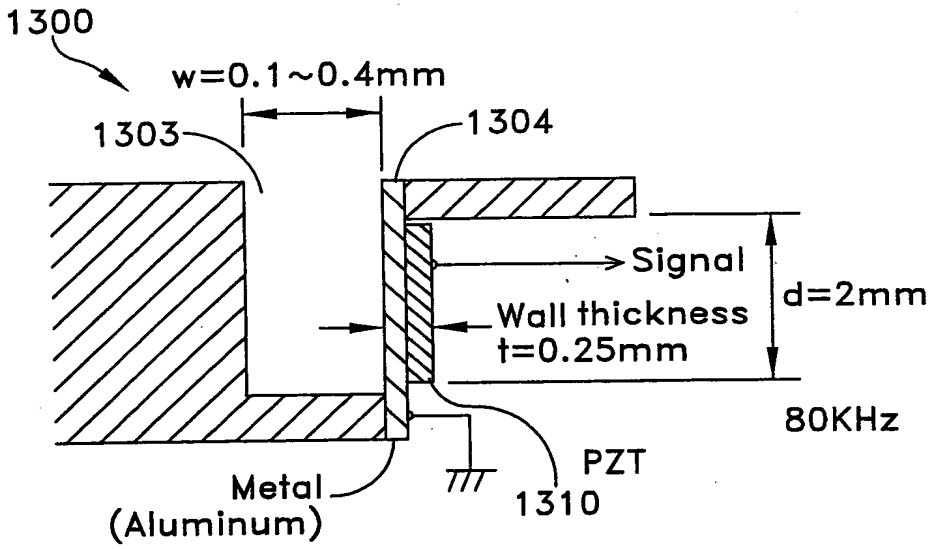

1300
w=0.1~0.4mm
1303
1304
Signal
d=2mm
Wall thickness
t=0.25mm
80KHz
PZT
1310
Metal
(Aluminum)

FIG. 36

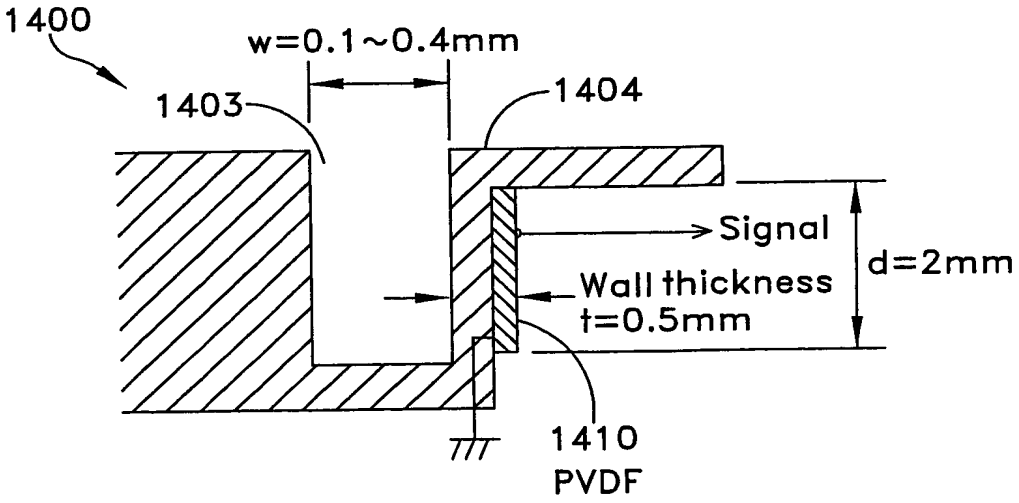

1400
w=0.1~0.4mm
1403
1404
Signal
d=2mm
Wall thickness
t=0.5mm
1410
PVDF

FIG. 37

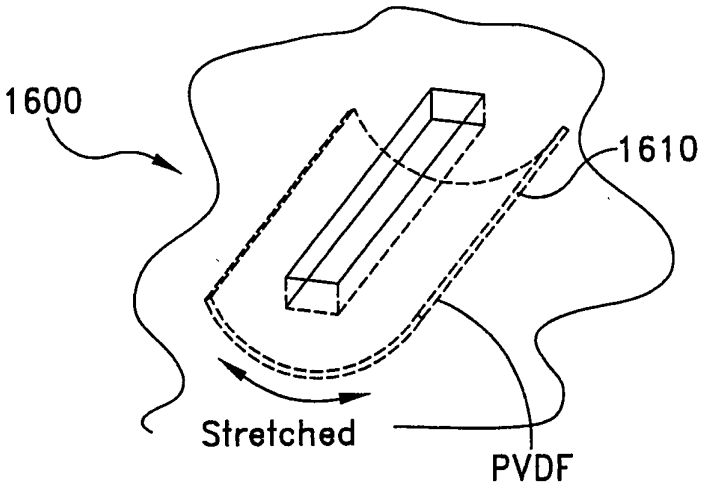


FIG. 38A

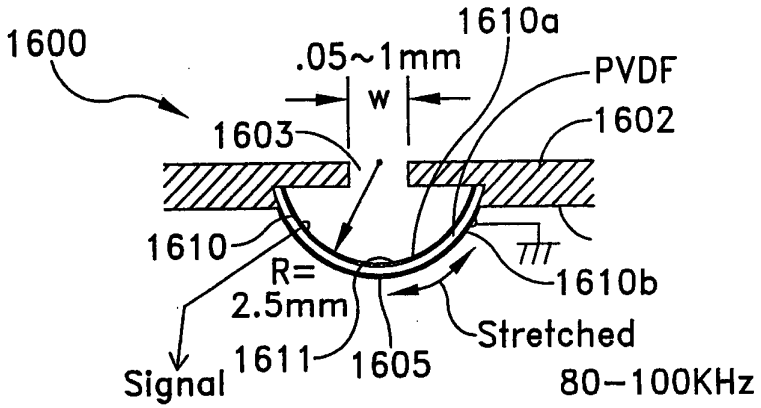


FIG. 38B

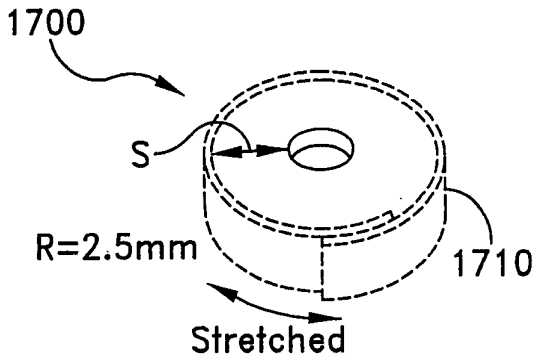


FIG. 39A

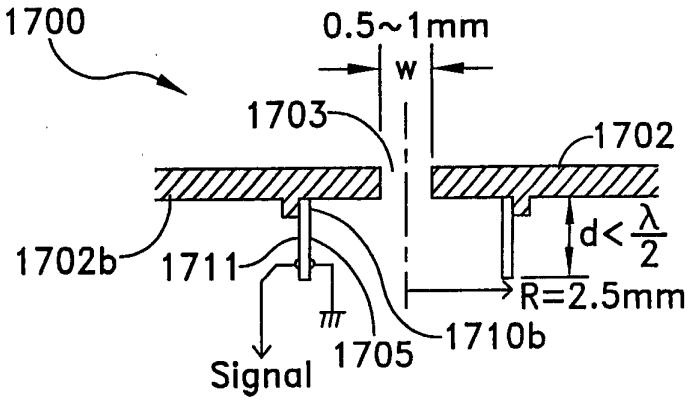


FIG. 39B

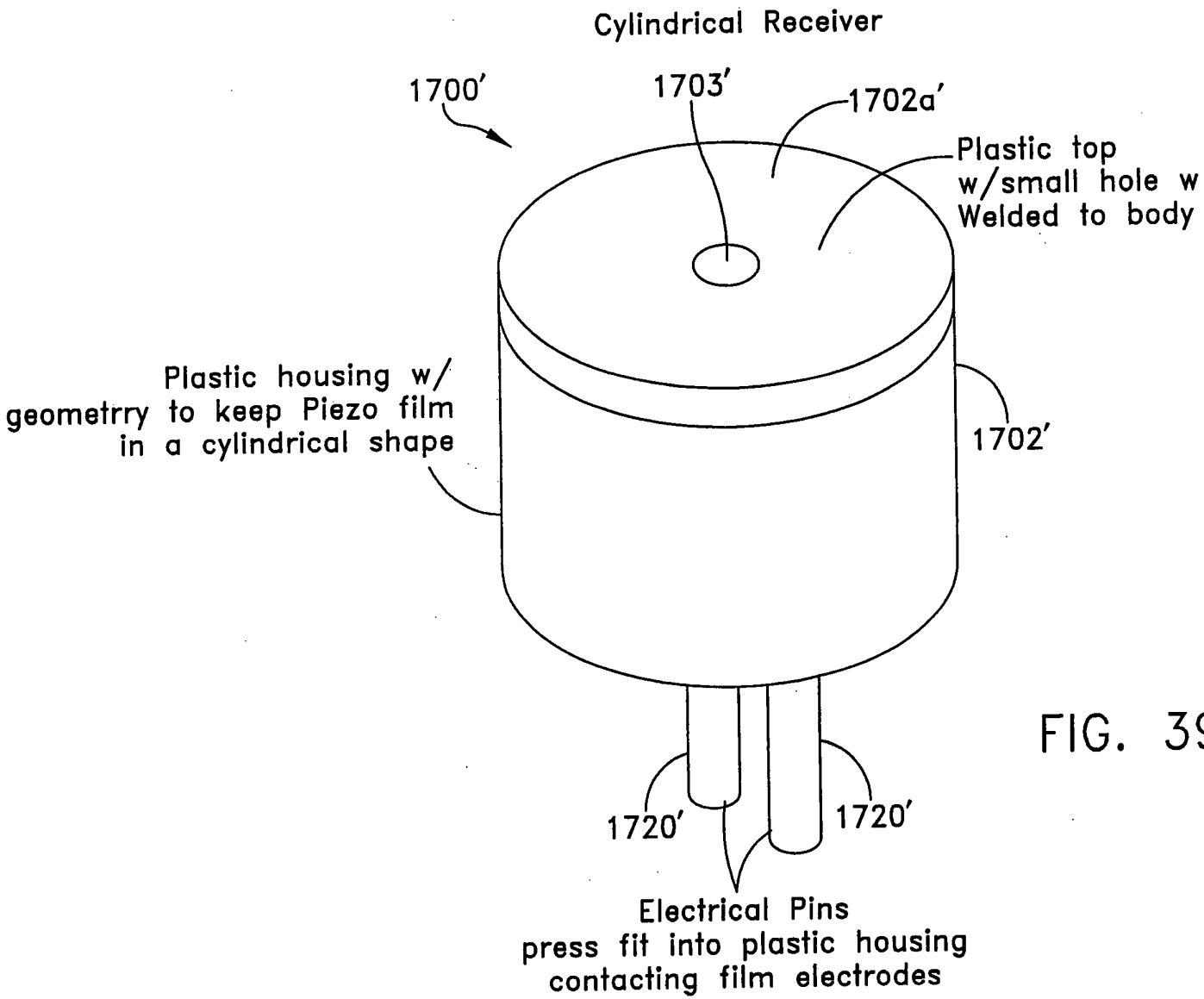

Cylindrical Receiver
1700'
1703'
1702a'
Plastic top
w/small hole w
Welded to body
Plastic housing w/
geometrry to keep Piezo film
in a cylindrical shape
1702'
1720'
1720'
Electrical Pins
press fit into plastic housing
contacting film electrodes

FIG. 39C

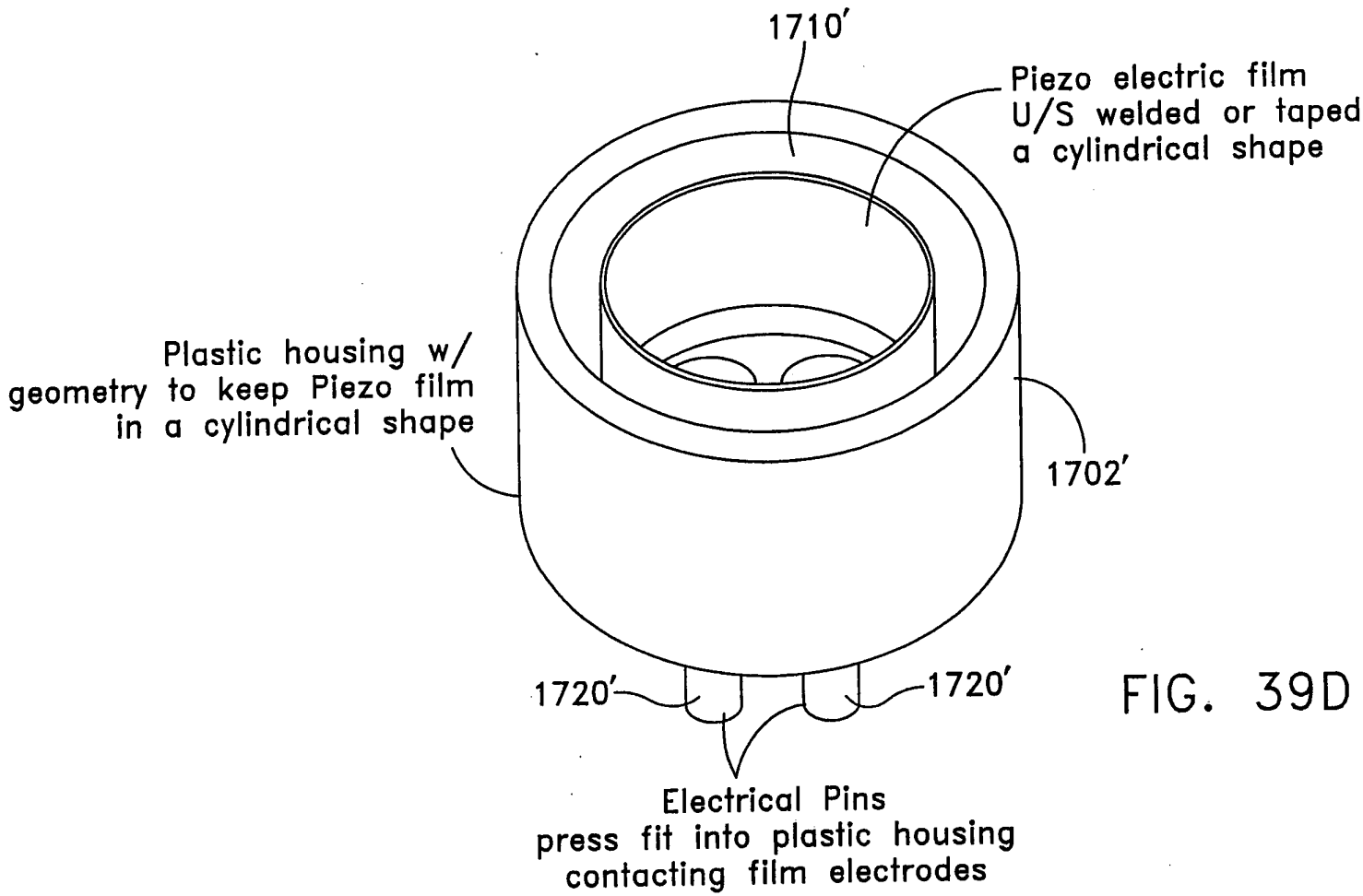

1710'
Piezo electric film
U/S welded or taped
a cylindrical shape
Plastic housing w/
geometry to keep Piezo film
in a cylindrical shape
1702'
1720'
1720'
Electrical Pins
press fit into plastic housing
contacting film electrodes

FIG. 39D

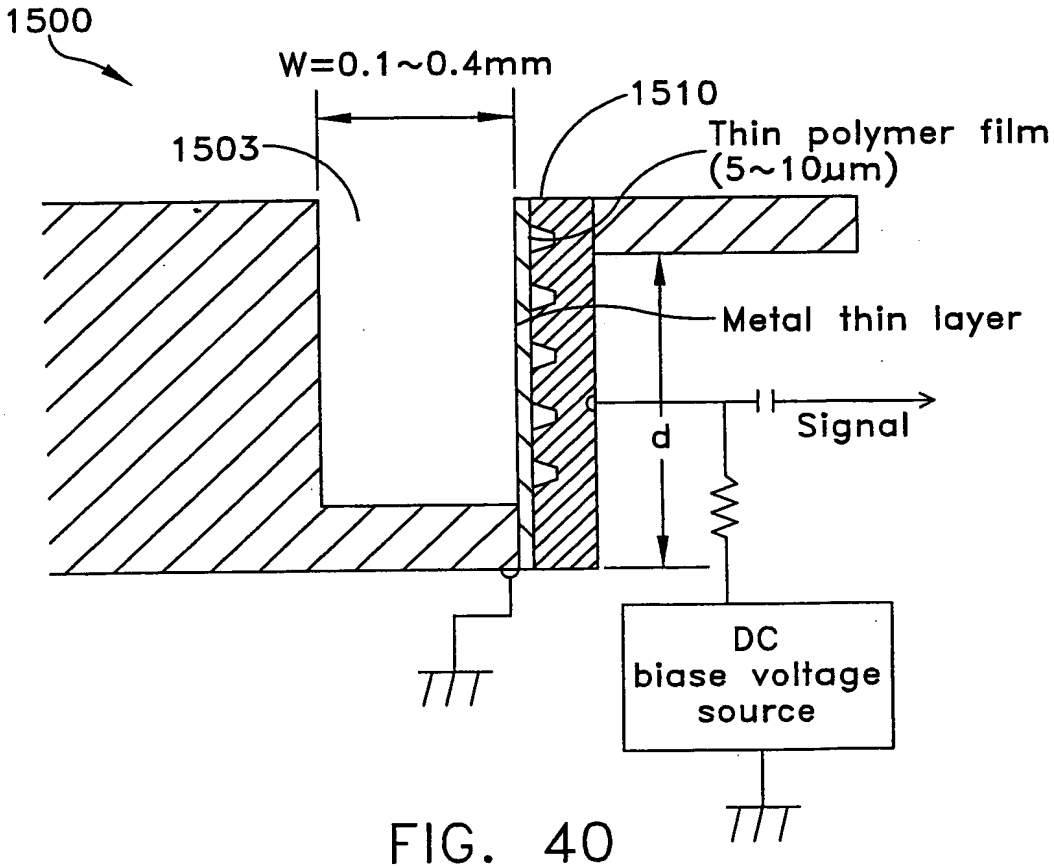

1500
W=0.1~0.4mm
1510
1503
Thin polymer film
(5~10μm)
Metal thin layer
Signal
d
DC
biase voltage
source

FIG. 40

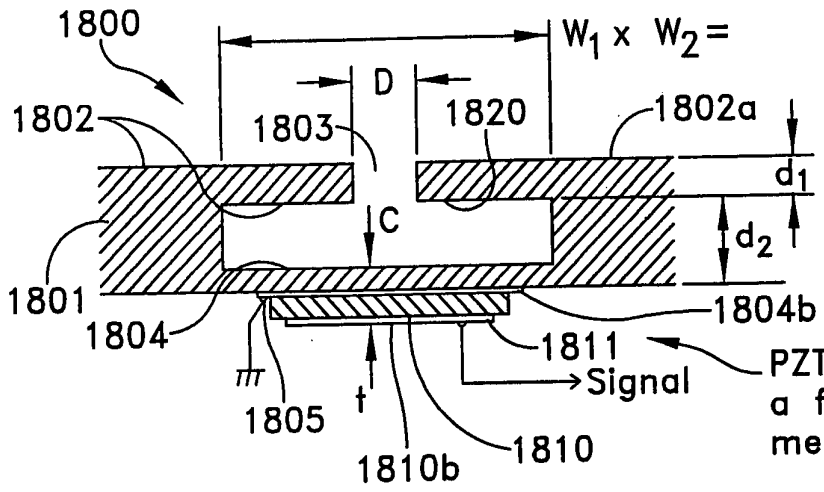


FIG. 41A

40KHx example:

D=1mm,	W_1=2mm W_2=2mm, or (b)	D=0.5mm	W_1=2mm W_2=2mm
mm	mm	mm	
d_1=0.3	d_2=0.52	d_1=0.3	d_2=0.18
0.5	0.35	0.5	0.12
0.75	0.24	0.75	0.09
1.0	0.17	1.0	0.05
1.5	0.05	1.5	0.02

FIG. 41B

Capacitive Micro Machined Ultrasonic Transducer (c–MUT)
Following numbers are example of c–MUT diaphragm; material is silicon nitride.
(a) 1–2 MHz range design (λ= 0.34 – 0.17 mm)
Diaphragm diameter; 50 um, thickness 0.5 – 1um
(b) 300 – 900KHz; (λ= 1.1 – 3.8 mm)
Diaphragm diameter; 200 um, thickness 2.5 – 7.5 um
(c) 80 –200 KHz design; (λ=4.3 – 1.7 mm)
Diaphragm diameter 0.4 mm, thickness 3 –7 um
In all the design, the diameters are roughly equal to quarter wavelength or smaller. In such a condition, the sensitivity has no angle dependence (no directivity).

Such a tranducer can be mounted on the surface of receiving equipment.

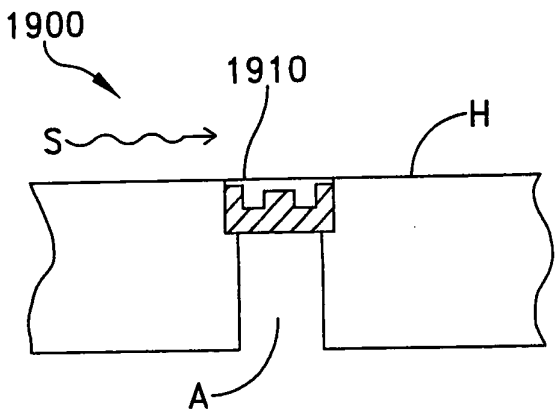


FIG. 42

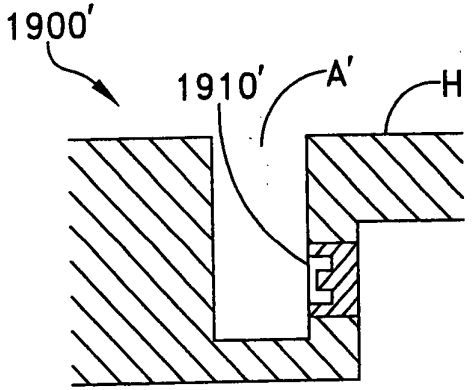


FIG. 43A

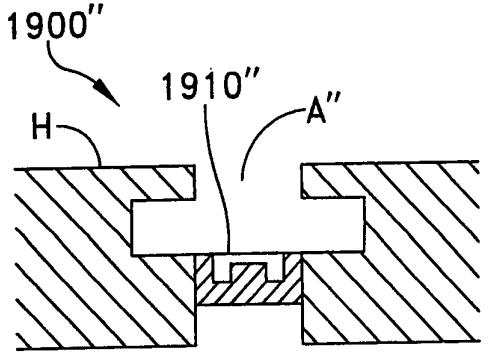


FIG. 43B

Desktop computer,

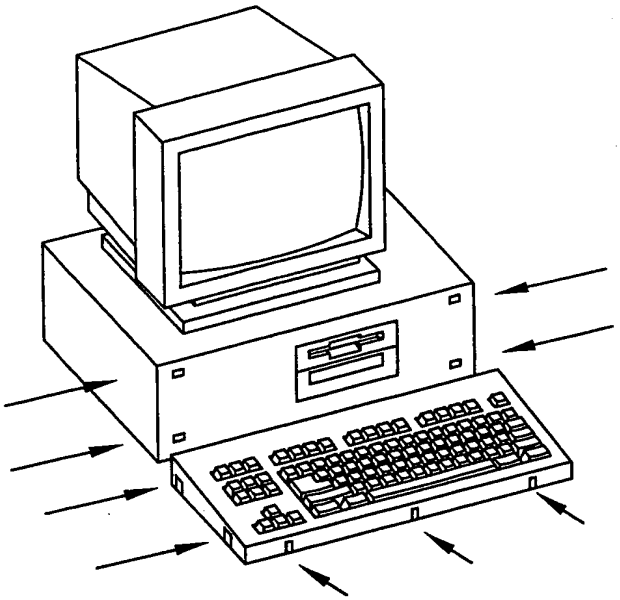


FIG. 44A

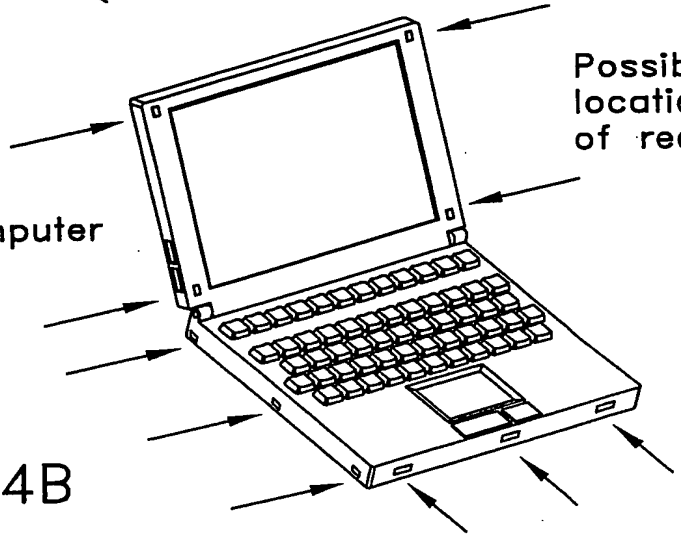


FIG. 44B

PDA

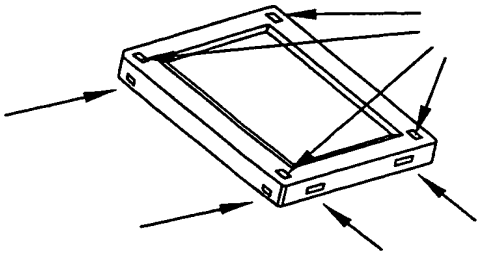


FIG. 44C

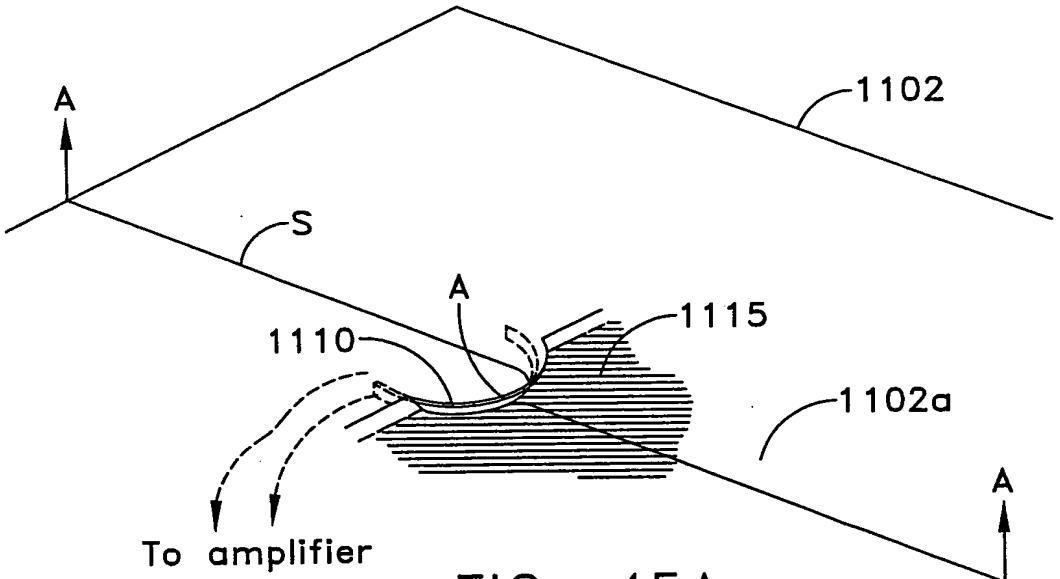
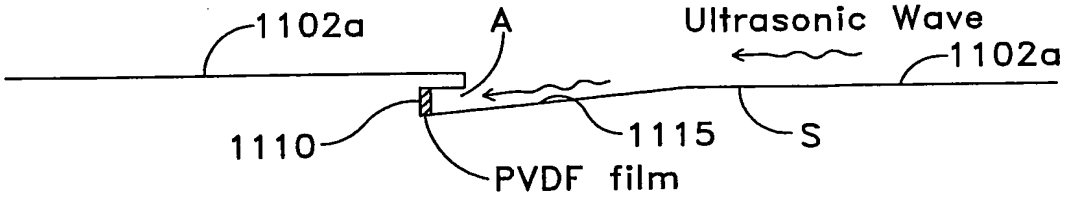


FIG. 45A



Cross Section from A–A

FIG. 45B